Social and Economic Research Project Reports *No. 6*

Internal and External Costs of Malaria Surveillance in Thailand

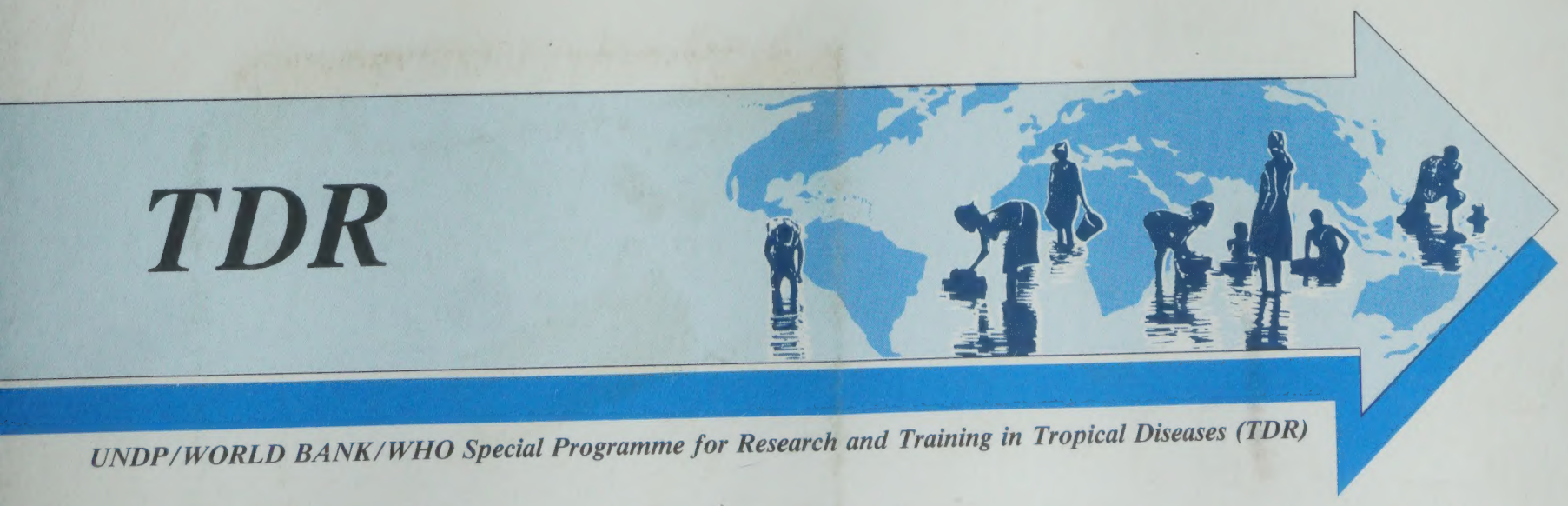
Final Report of a project supported by the TDR Social and Economic Research Component

Somkid Kaewsonthi
Chulalongkorn University
Bangkok 10330, Thailand

Advisors

Somthas Malikul
Ministry of Public Health
Thailand

Alan G. Harding
ITC, Netherlands



TDR

UNDP/WORLD BANK/WHO Special Programme for Research and Training in Tropical Diseases (TDR)

Social and Economic Research Project Reports *No. 6*

Internal and External Costs of Malaria Surveillance in Thailand

Final Report of a project supported by the TDR Social and Economic Research Component

Somkid Kaewsonthi
Chulalongkorn University
Bangkok 10330, Thailand

Advisors

Somthas Malikul
Ministry of Public Health
Thailand

Alan G. Harding
ITC, Netherlands

UNDP/WORLD BANK/WHO Special Programme for Research and Training in Tropical Diseases (TDR)

TDR/SER/PRS/6

SER Project Reports *appear as part of a series of unedited final reports resulting from projects supported by the UNDP/WORLD BANK/WHO Special Programme for Research and Training in Tropical Diseases (TDR). These reports are submitted to the TDR Steering Committee on Social and Economic Research for review and evaluation upon completion of a project. Project reports included in this series have not been published in their entirety elsewhere.*

The designations employed and the presentation of the material in ***SER Project Reports*** *do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.*

Authors alone are responsible for the views expressed in ***SER Project Reports*** *and for the presentation of the material contained therein.*

Foreword

The UNDP/WORLD BANK/WHO Special Programme for Research and Training in Tropical Diseases (TDR) is a globally coordinated effort to bring the resources of modern science to bear on the control of major tropical diseases. The Programme has two interdependent objectives:

- To develop new methods of preventing, diagnosing and treating selected tropical diseases, methods that would be applicable, acceptable and affordable by developing countries, require minimal skills or supervision and be readily integrated into the health services of these countries;

- To strengthen -- through training in biomedical and social sciences and through support to institutions -- the capability of developing countries to undertake the research required to develop these new disease control technologies.

Research is conducted on a global basis by multidisciplinary Scientific Working Groups on the six diseases selected for attack: malaria, schistosomiasis, filariasis (including onchocerciasis), the trypanosomiases (both African sleeping sickness and the American form, Chagas disease), the leishmaniases and leprosy. Scientific Working Groups are also active in the "trans-disease" areas of biological control of vectors, epidemiology, and social and economic research. The training and institution strengthening activities are limited to the tropical countries where the diseases are endemic.

The *Social and Economic Research Project Reports* series represents a new communication venture undertaken by TDR's Social and Economic Research (SER) Component. This series has been launched to facilitate and increase communication among social scientists and researchers in related disciplines carrying out research on social and economic aspects of tropical diseases and to disseminate social and economic research results to disease control personnel and government officials concerned with improving the effectiveness of tropical disease control.

Research reports published in this series are final reports of projects funded by TDR and usually include more material than ordinarily published in peer review journal articles. TDR considers this material to be valuable both for investigators involved in the study of social and economic aspects of tropical diseases and for professionals involved in training programmes in the social sciences, economics and public health. The series should acquaint those working on similar problems with approaches undertaken by others, in order to test new approaches in different settings, and should provide useful information to personnel in disease control programmes and related agencies.

All requests for further information should be addressed to: Dr C. Vlassoff, Secretary, Steering Committee on Social and Economic Research, TDR, World Health Organization, 1211 Geneva 27, Switzerland.

Tore Godal, Director

Special Programme for Research
and Training in Tropical Diseases
TDR

PREFACE

Since 1979 the Social and Economic Research (SER) Component of the UNDP/WORLD BANK/WHO Special Programme for Research and Training in Tropical Diseases (TDR) has been supporting research aimed at improving the effectiveness of disease control programmes through the incorporation of social, cultural and economic factors into the design and implementation of control programme activities. In aiming towards this overall final objective, two intermediate objectives guide TDR's social and economic research activities:

- To determine the impact of social, cultural, demographic and economic conditions on disaease transmission and control.

- To promote the design and use of cost-effective and acceptable disease control programmes and policies.

This study constitutes the second of two consecutive projects concerned with the economic assessment of malaria control activities in Thailand. The first, entitled, "Costs and Performance of Malaria Surveillance and Monitoring in Thailand: A Retrospective Study Based on Apportionment of Expenditure Under Budget Headings", was recently released as SER Project Report No. 5. Whereas the previous study related to the second intermediate objective of SER, the present report is directed towards the final objective in that it seeks to improve malaria control programmes through the provision of economic tools and methods for the use of malaria managers.

The study reported here represents conscientious and painstaking efforts on the part of Professor Kaewsonthi and her team to investigate the total costs of the malaria surveillance programme in Thailand. These include not only programme costs such as personnel, equipment and medicine but also costs to patients in seeking treatment in terms of time lost from work, travel costs and medical expenses. The report also recommends strategies for improving the quality of services at minimum cost. A number of tools described in the report were made available to the Malaria Division, including computer programmes for operational and financial monitoring and control as well as conceptual tools for malaria control personnel.

Carol Vlassoff, Secretary
Scientific Working Group and Steering Committee
on Social and Economic Research

Special Programme for Research
and Training in Tropical Diseases
TDR

ACKNOWLEDGEMENTS

I wish to acknowledge the financial and practical support received from the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) which made this project possible and to thank them for their confidence in the Principal Investigator.

The successful completion of this project is the result of the efforts of many people. It is both a pleasure and privilege to acknowledge their contributions.

Director of the Malaria Division
Dr. Somthas Malikul, gave total and constant cooperation and provided meticulous management of the field surveys. He reexamined completely open to a study which explored the operations of the Division and is already exploring ways in which the findings and tools can be used to secure improved effectiveness and efficiency.

Staff of Malaria Division
The staff of the Division from field personnel to the Division Headquarters contributed to this project. Particular thanks are given to the staff of Zone 3 and Zone 7 and headquarters staff in Region 1 for their time and total commitment. Without their contribution throughout a long year, no data could have been gathered.

Computer Specialists
Mr. Jeerasak Tongtar and Mr. Pongsa Pornchaiwiseskul worked long hours to develop the programmes which were central to handling the quantities of data obtained. They remained tolerant and cheerful in the face of my requests for changes to the functions and output of programme.

Research Assistant and Secretary
Miss Somsri Luansritisakul is a competent perfectionist whose commitment and contribution were essential to the handling of data, and the presentation of the reports.

Advisor
Dr. Alan G. Harding although simply termed 'advisor' has, as in earlier work, facilitated the birth of ideas, nurtured the process of analysis and contributed so much to setting and achieving high standards in the design of the project and in the handling and presentation of results. Thankfully we continue to disclose doubts, and ignorance (among ourselves) rather than hiding uncertainties behind a facade of knowledge and competence.

Somkid Kaewsonthi
May 19, 1988

CONTENTS

1. INTRODUCTION

This report presents an analysis of the internal costs (costs to the Malaria Division) of malaria control operations in Thailand and the external costs (costs incurred by patients using malaria surveillance services). The study also examines the way in which such information may be gathered and used by malaria control managers to improve efficiency of surveillance operations.

1.1 The Case for Cost analysis

The goals of the Anti-Malaria Programme, as expressed in the Fifth National Social and Economic Development Plan of Thailand (1982-86) were:

(i) to reduce mortality caused by malaria to less than 8 per 100,000 population;
(ii) to reduce morbidity caused by malaria, in control areas, to less than 12 per 1,000 population;
(iii) to prevent the reintroduction and retransmission of malaria in eradication areas by having not more than one indigenous case per 10,000 population;
(iv) to implement a Primary Health Care approach to malaria control and to involve the local community in personal protection measures by
- supporting village health volunteers in the efficient implementation of malaria control strategies; and
- ensuring that 50% of Village Malaria Volunteers (VMV) and Village Health Centres (VHC) should be effective in contributing to malaria control.

To achieve these objectives, the Malaria Division strives to use its available resources through a judicious mix of activities and services (Section 2) concerned with prevention, detection and treatment appropriate to particular areas. Such stratification of the country requires the definition of different objectives for each type of area and then selection of appropriate control measures, in relation to the resources available (WHO 1985).

To make informed decisions on the selection of appropriate control measures, three major sets of information are required :

(i) social, economic, demographic and geographic information for each area;
(ii) the disease, its distribution and current control measures;
(iii) costs and performance of control activities and field services.

The collection and updating of information relating to many parts of (i) and (ii) above are very well organized and built into the operational system of the Malaria Division at the field level.

The existing monitoring system also provides some information on performance i.e. relative contribution of services, slide positive rate (SPR), annual parasite incidence per thousand population (API) and the

time between taking a blood slide and providing radical treatment. However, some key areas concerning efficiency of prevention and case detection are not regularly monitored. In particular, the costs of operational units and field services are not known and no system exists by which they can be conveniently determined. Budget headings of the Malaria Division show no relation to expenditure by operational units, activities or field services.

Costs to the Malaria Division are of course, only one part of the total costs. Malaria is a communicable disease primarily of the rural poor. Infected individuals and the community incur costs as a result of the disease in addition to the control and treatment costs incurred by the Malaria Division.

In seeking to optimize operational efficiency in control (outcome of malaria control/input for a given medical technology), it may be argued that aggregate costs (costs to the Malaria Division plus costs to individuals) should be considered.

Whether efforts are made to optimize the nature, performance, number and/or location of operational services with respect to internal costs alone, or aggregate costs, information on relevant costs and performance is essential. Only then can efficiency be improved and suitable responses made to changes in conditions, budget and/or strategy. At the moment, malaria managers struggle to make such informed decisions without an economic framework by which those decisions can be made.

1.2 Objectives

Objectives of the project were determined by two goals of the Strategic Plan of the SER Scientific Working Group; to determine the costs of control measures and to ensure that use is made of the findings by the relevant disease control organizations.

Short-term objectives :

(i) determine the costs of surveillance services (internal costs to the Malaria Division) concurrent with activities and evaluate procedures;
(ii) determine the costs incurred by patients (external costs) in attending different types of surveillance services;
(iii) determine patients' performance (number of days between the onset of symptoms and seeking care) in relation to type of service and the effect of patients' performance on costs to patients;
(iv) determine the performance of services (number of days between taking a blood slide and providing radical treatment to positive cases) and the effect of performance on costs to patients;
(v) strengthen the research competence of some Malaria Division staff.

Medium-term objectives :

(vi) provide malaria managers with practicable and effective tools by which the component costs of surveillance activities and services may be measured and targets set; and

(vii) provide malaria managers with information and procedures by which some optimization in the supply of services may be realized.

Long-term objectives :

(viii) provide information and insights on economic concepts and methods which may be beneficial to malaria managers in and outside Thailand.

1.3 Previous Work

Kaewsonthi (1983, 1989) and Kaewsonthi and Harding (1984) studied HOW to measure the costs and performance of malaria surveillance and monitoring measures in two zones in Thailand. The work yielded three outcomes :

(i) Costs
A micro cost model was developed for determining direct and indirect costs of malaria operational units and services through apportionment of budget expenditures. Since no measurements were made of actual expenditure, the validity of the apportionment procedures and resultant costs could not be assessed. Costs incurred by patients attending all malaria clinics in Region 1 over a four week period were also determined.

(ii) Performance
Techniques for measuring the performance of operational services were explored and data gathered for the two zones.

(iii) Effects?
On publication of the results the Malaria Division made a number of changes in practice. These included (1) a reduction in one service with a high cost per case (Active Case Detection), (2) change in follow up procedures, (3) establishment of a systematic check on the time between the taking of blood slides and provision of radical treatment, (4) a project was started to explore how the time between taking blood slides by Village Malaria Volunteers and the provision of radical treatment could be reduced, and (5) a major revision of monitoring forms and procedures.

Barlow and Grobar (1985) reviewed published data on the costs and benefits of controlling parasitic diseases, including a section on malaria. They produced what were termed cost effectiveness ratios; the annual cost per person protected, cost per case prevented and cost per death averted. The specific circumstances and assumptions made in each study make comparisons highly suspect.

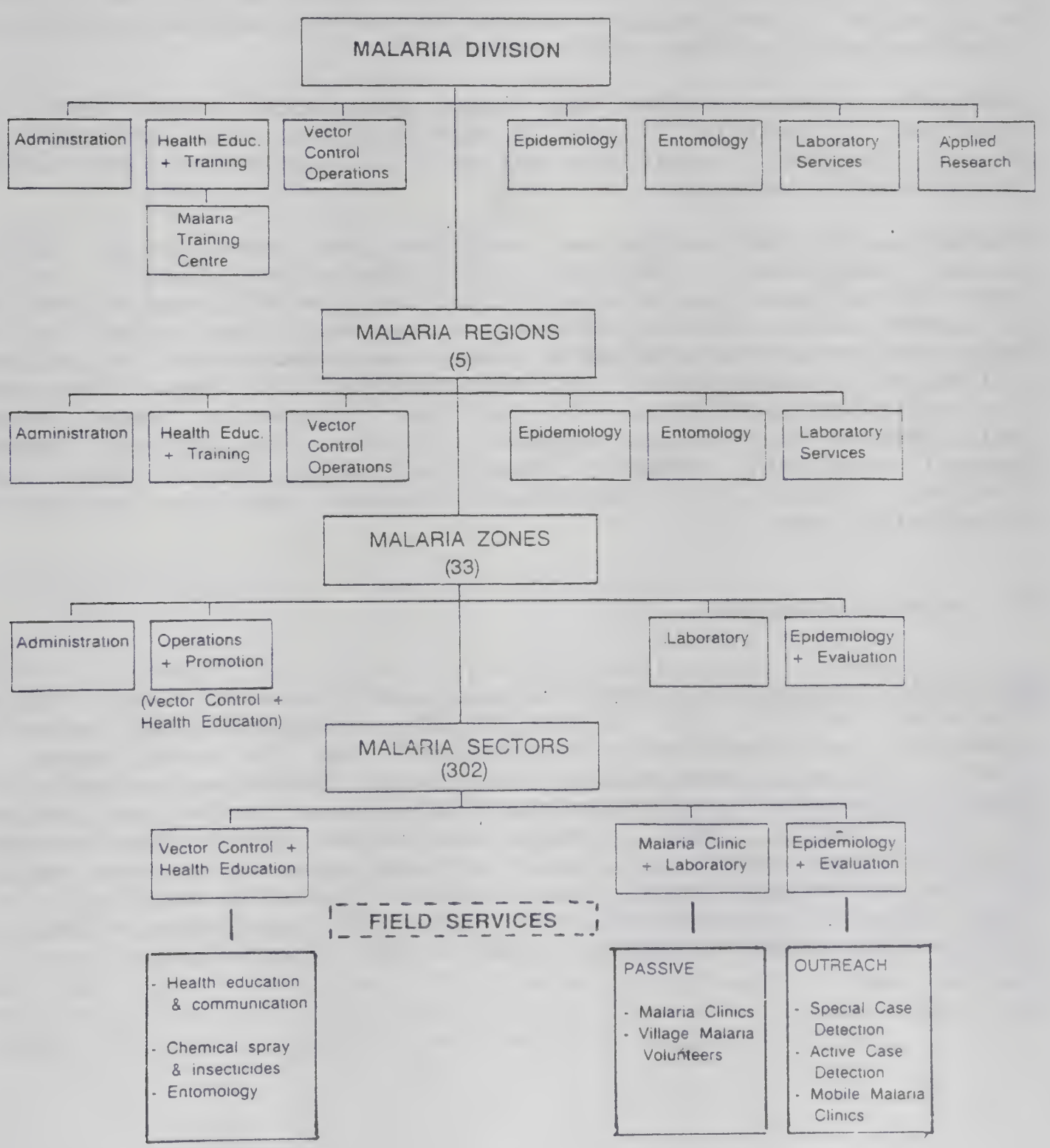
Mills (1987) reported on the cost effectiveness of malaria control strategies in Nepal. It may be argued that Mills has not measured cost effectiveness since two necessary conditions for comparing cost effectiveness are not met; services are complementary rather than alternatives and there is no common target performance [Kaewsonthi and Harding (1986 a)]. However, several of the findings and recommendations concur with earlier work in Thailand (Kaewsonthi 1983, 1989) even though conditions and the control organization in Nepal are clearly different. Among the findings are a high cost per positive case for ACD coupled with a low slide positive rate, a long and deleterious time between taking a blood slide and the provision of radical treatment (four times the average in Thailand), marked differences in costs and costs per case among areas and the annoying anomaly that the efficiency of services falls (i.e. the cost/case rises) as API falls, due to the high proportion of fixed costs.

Mills' views a fall in API in an area as indicative of more effective control. While this is a natural conclusion, alternative explanations can not be ignored; ineffective surveillance, changes in conditions (Beales 1986), patients using services in other zones [Kaewsonthi and Malikul (1986); Kaewsonthi and Harding (1986 b) and/or an increase in the ratio of asymptomatic to symptomatic cases (Kaewsonthi 1983).

2. ANTI-MALARIA PROGRAMME IN THAILAND

The Malaria Division, a division of the Department of Communicable Disease Control, Ministry of Public Health administers antivector and antiparasite measures through five regional offices. The organization of the Malaria Division is shown in Figure 1. The management levels of Division, region, zone and sector divide their tasks among a set of operational services with sector operational units providing the field services.

Figure 1. Organization of the Malaria Division



2.1 Strategy

The global strategy for malaria control is to reduce the prevalence of the disease to where there is no longer a major public health problem taking into account the local conditions and best that one can achieve with the available means (WHO 1986). The specific strategy adopted in Thailand is long-term malaria control in the control areas with prevention of the re-establishment of transmission in the eradication areas.

Control areas, with a population of 12 million are largely forested hills/mountains and border areas where terrain, occupational migration and security problems contribute to the high incidence (Kondrashin 1986). The objective in the long-run is control of endemic malaria and reduction in serious health problems due to malaria.

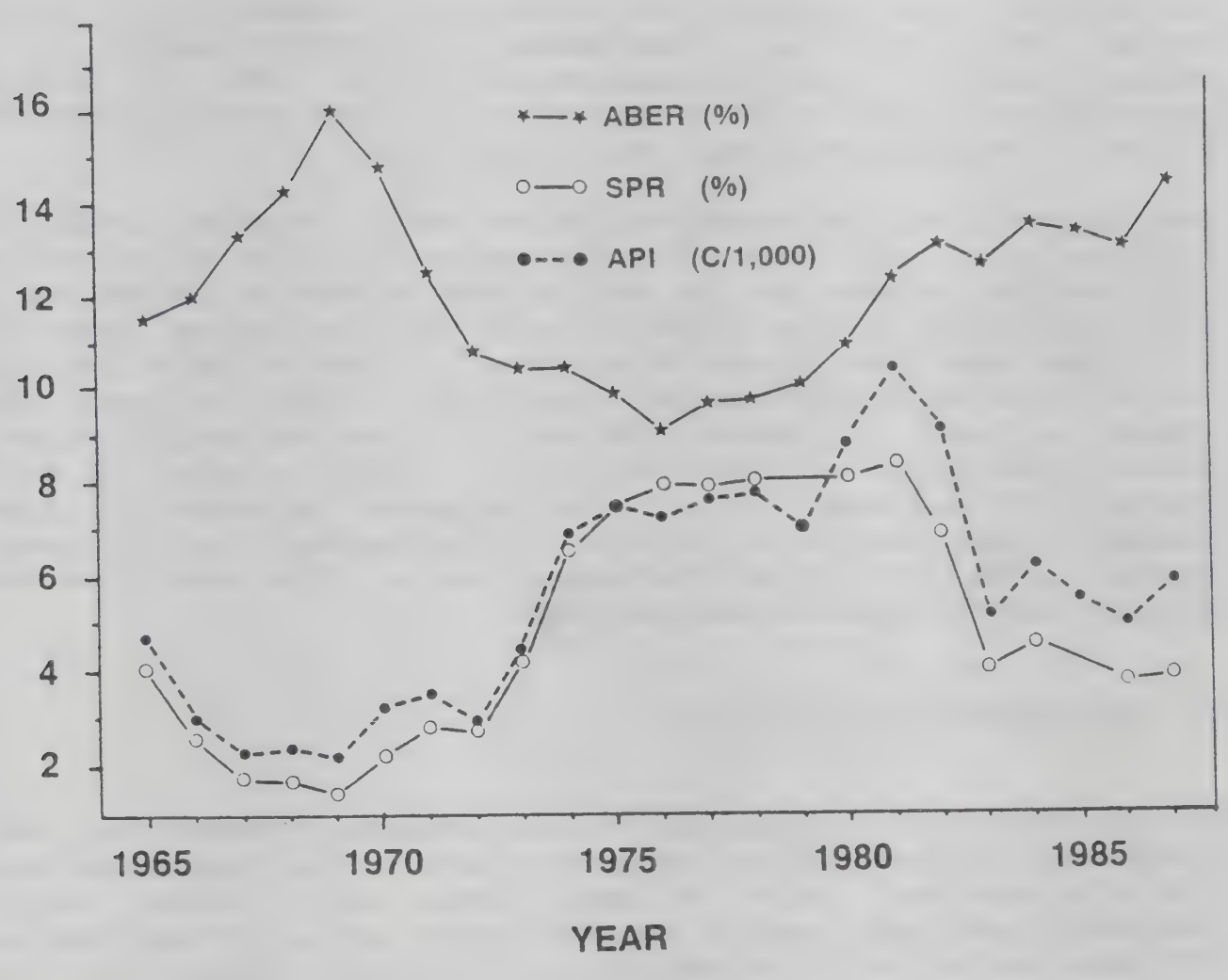
Eradication areas are urban and large agricultural areas where the prevalence of malaria is not a major health problem. Outbreaks are quickly controlled. Seventy six percent of the population (38 million) live in eradication areas.

Eradication, in 1986, was further subdivided into consolidation (0.7%), partial integration (76%) and full integration (23.3%). In the consolidation phase, the Malaria Division uses the full range of services to prevent malaria becoming endemic and resolve problems as soon as they arise. In the partial integration phase, case detection is by patients calling at service points with some responsibility for actions shared with public health officers. In the full integration phase, normal public health services are responsible for case detection and treatment (general hospitals, community hospitals, public health posts and midwifery centers) with the Malaria Division providing training and antimalarial drugs.

2.2 Malaria Situation

Nationally, the mortality rate from malaria fell from 15.8 per 100,000 population in 1974, to 3.5 per 100,000 population in 1985 due to the expansion of peripheral health care delivery and the establishment of malaria clinics in areas of high transmission (Pinichpongse, 1986). The causes of the majority of deaths remain undiagnosed in Thailand (Ministry of Public Health, 1986). However, effective health education about malaria and the network of local services operated by the Malaria Division provide confidence in the mortality figures for malaria.
Annual Parasite Incidence (API) was 5.6 per 1,000 population in 1985 with an Annual Blood Examination Rate (ABER) of 12% (Figure 2).

Figure 2. Malaria Surveillance Statistics (1965 - 1987)



2.3 Control Operations

Malaria control is achieved through antiparasite activities (case detection and treatment), antivector activities (vector control and entomology), and health education.

Surveillance is essentially the system for collecting and examining blood smears taken from patients who may have malaria, providing radical treatment to positive cases and tracking the source of infection. Patients may call at passive services managed by the Malaria Division (Malaria Clinics [MC] and Village Malaria Volunteers [VMV]) and at services managed by other departments of the Ministry of Public Health (Village Health Centres [VHC] and Hospitals [H]). Surveillance services may also visit individuals or groups of patients. These outreach services include Active Case Detection [ACD], visiting houses, Mass Blood Surveys [MBS], of a community and Special Case Detection [SCD].

3. CONCEPTUAL FRAMEWORK

This section first presents a conceptual framework for determining internal costs by direct measurement and apportionment, (3.1) and external costs by direct measurement (3.2). This is followed by proposals on how the relation between apportioned and measured costs can be used to improve operational activities (3.3).

Four models are then described in Section 3.4 by which performance and efficiency (cost/unit outcome) can be improved; a pool of infection model which provides guidance on the best actions to take to reduce the pool of infection (3.4.1); a case prevented model which estimates cases prevented in a given year from current data (3.4.2); a pool of infection model and short run cost model under budget constraints which indicate the best actions to take to reduce the pool of infection having regard to the costs of alternative actions (3.4.3) and, finally, a model for minimizing internal and external costs which suggests the number of cases to be detected by each service to minimize the aggregate cost (internal and external costs) at given incidence levels. This model also serves to show how best to re-distribute services.

3.1 Determining Internal Costs

The organization of the Malaria Division (Figure 1) shows that costs may be expressed at each of four management levels (e.g. region and zone), in terms of operational units at each level (e.g. vector control and laboratory services) and at the sub-sector level, by the field services which have contact with the public (e.g. malaria clinics and spraying teams).

To determine costs, (1) headquarters expenditure under budget headings must be assigned to specific operational units and field services, and (2) a proportion of the costs at each level must be assigned to operational units and services at a lower level. Such costing may be achieved by apportionment and/or direct measurement. Both methods are compared in this study.

3.1.1 Apportionment of expenditure

Apportionment requires that informed judgments are made about the criteria by which expenditure under budget headings should be distributed among the operational units at that level and a proportion of the costs of each operational unit assigned to each lower level (Figure 3).

Figure 3. System for Determining the Costs of Operational Units Through Apportionment

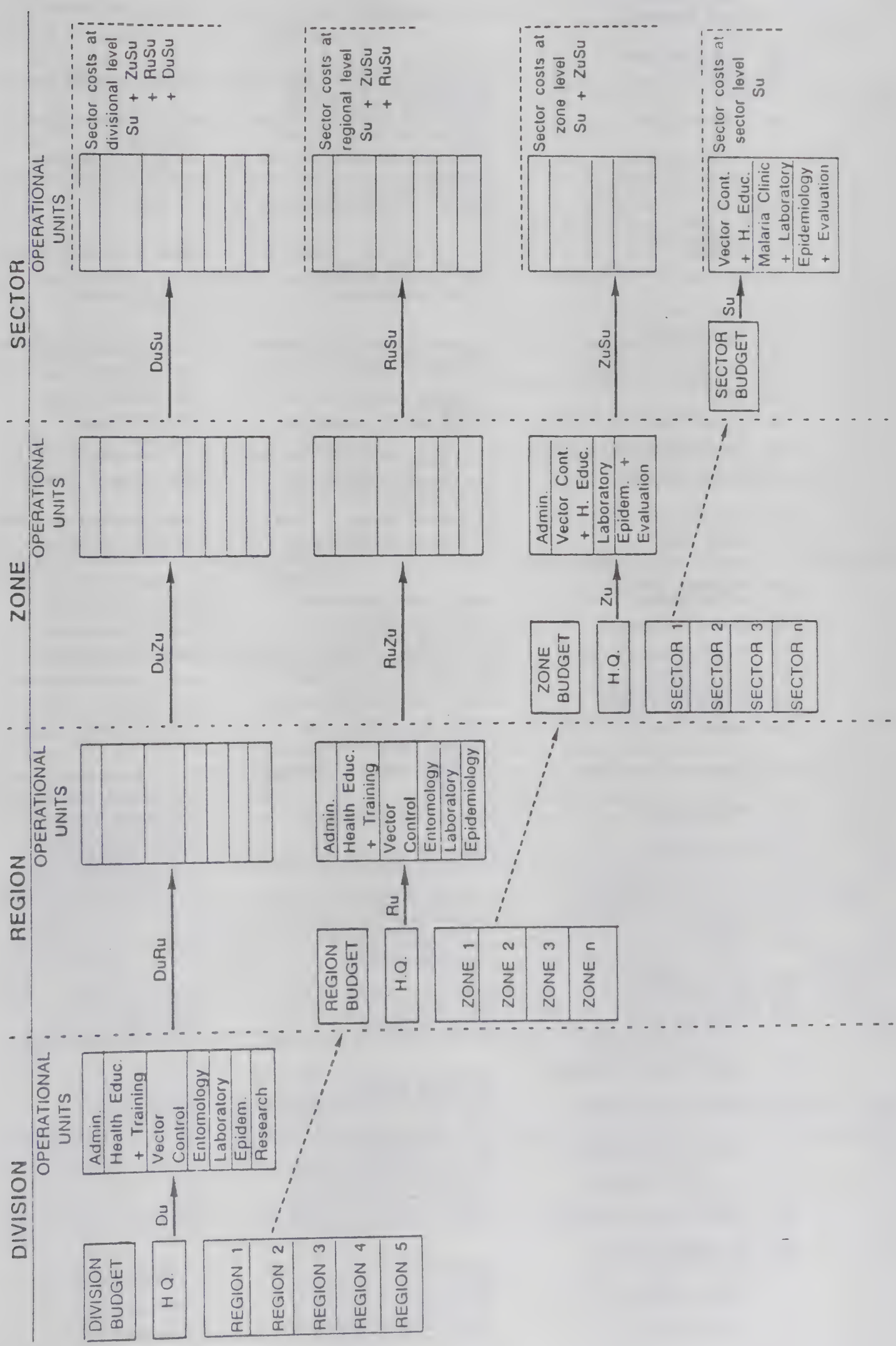


Figure 4. Criteria for Apportioning Headquarters Budgets to Operational Units at the Same Level

	BUDGET HEADINGS	DESCRIPTION	APPORTIONMENT CRITERIA
100	Salary and Wages		
101	Salary	- Salary of civil servants	- Civil servant salaries
102	Permanent wage	- Wages of full time permanent employees who are not given positions as civil servants	- Monthly permanent wage
103	Temporary wage	- Wages for full time / part time employees who lack permanent status	- Monthly temporary wage and/or direct to units concerned
104	Remote subsidy	- Disturbance allowance for civil servants	- No. of civil servants working in remote areas
105	Ex-military service	- Allowance for those who previously served military service	- No. of ex-military staff
200	Compensation		
201	Overtime	- Overtime for civil servants and permanent wage earners	- Direct to units concerned
202	Housing	- Civil servants allowance for renting accommodation	- No. of civil servant received housing allowance
300	Remuneration		
301	Service bulk purchase	- Transport of centrally purchased supplies from docks	- Direct to units concerned
302	Maintenance of vehicles	- Maintenance charges of vehicles	- Time in which transport is used
303	Fees	- Non public utility fees and charges	- Equally distributed
304	Property rent	- Rent of office building and property	- Direct to units concerned
305	Instalment of public utility	- Instalment and maintenance of fixed assets	- Direct to administration
306	Travel allowance	- Per diem and transport when travelling away from normal place of work	- Duty travel of personnel
307	Maintenance of fixed assets	- Maintenance charges of fixed asset	- Direct to units concerned
308	Small items	- Small items of expenditure	- Direct to adminstration
400	Consumable Supply		
401	Office supplies	- Papers, forms, stationery, consumables, etc.	- Equally distributed
402	Electrical supplies	- Repairs and spares for electrical equipment	- Equally distributed
403	House keeping supplies	- Supply of materials and consumable used for housekeeping	- Equally distributed
404	Small construction / maintenance supplies	- Materials used to maintain buildings and fixtures	- Direct to administration
405	Auto parts & supply	- Repairs and spares for vehicles	- Time in which transport is used
406	Petrol / oil	- Cost of fuel provided at division, region and zone offices	- Time in which transport is used
407	Laboratory consumable	- Laboratory chemical centrally purchased	- Centrally purchased supplies are excluded and analysed seperately
408	Medical supplies	- Drugs centrally purchased	- Centrally purchased supplies are excluded and analysed seperately
409	Spray chemical	- Chemical spray, DDT and larvicides centrally purchased	- Centrally purchased supplies are excluded and analysed seperately
410	Agricultural supplies	- Supply of of plants and larvivorous fish	- Direct to units concerned
411	Advertising / education supplies	- Posters, printing, audio tapes; provided centrally	- Direct to unit concerned
412	Others	- Small items of supply i.e. workers uniform	- Direct to administration
500	Public Utility		
501	Electricity	- Electricity charges	- Total staff
502	Water	- Water charges	- Total staff
503	Telephone	- Telephone charges	- Total staff
504	Postage / telegramme	- Postage and telegramme charges	- Direct to administration
600	Land Building and Equipment		
601	Office fixture / furniture	- Book shelves, tables, cupboards and office funiture	- Direct to units concerned
602	Automobile / transport	- Van, automobiles, motor-cycles etc.	- Direct to units concerned
603	Agricultural equipment	- Tools and equipment for gardening and larviciding	- Direct to units concerned
604	Construction equipment	- Tools and quipment for maintenance of fixed assets	- Direct to administration-
605	Electrical equipment	- Tool and equipment for maintenance of electricity	- Direct to units concerned
606	Advertisement / equipment	- Health education AV. equipments	- Direct to health eduction
607	Chemical medical equipment	- Chemical-spray equipments	- Direct to vector control
700	Government Welfare		
701	Subsistance	- Subsistance	- Permanent staff
702	Health / medical care	- Re-imbursement of medical expenses	- Permanent staff
703	Childrens education	- Social welfare; payment of fees for childrens education	- Permanent staff
704	Children subsidy	- Social welfare; payment of subsidy for children	- Permanent staff

A variety of criteria were developed and tested. the most suitable set of criteria are show in Figures 4 and 5 : headquarters to operational units (Du(A), Ru(A), Zu(A), Su(A)] in Figure 4 and operational units to operational units at a lower level [DuRu(A), DuZu(A), DuSu(A), RuZu(A), RuSu(A), ZuSu(A)] in Figure 5.

Figure 5. Indexes for Apportioning Costs of Operational Units to a Lower Level

Administration and Research	- Equally distributed in relation to the number of regions, zones or sectors at the lower level
Health Education and Training	- Health Education Index (H)
Vector Control	- Vector Control Index (V)
Entomology	- Entomology Index (N)
Laboratory	- Laboratory Service Index (S)
Epidemiology	- Epidemiology Index (E)
Centrally purchased supplies	- Costs based on needs index (C)

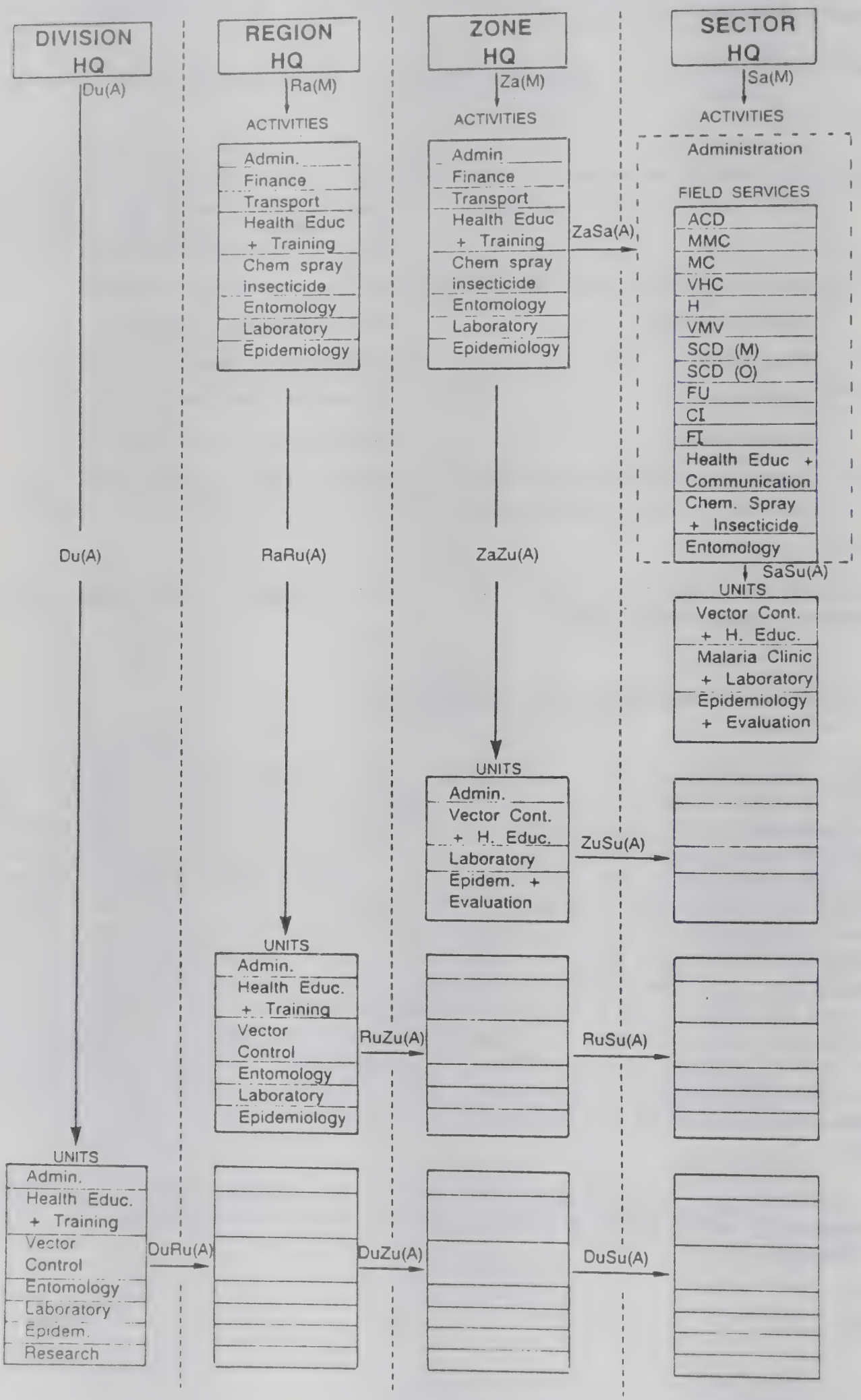
The nature and justification for these indexes have been explained elsewhere (Kaewsonthi 1988).

3.1.2 Direct measurement of expenditure

Direct measurement of expenditure from headquarters budgets, at each level, to operational units at the same level can, in principle, replace apportionment. In practice it is very difficult. Measurement was therefore made of expenditure to a set of operational activities at each level and then costs of operational activities apportioned to operational units. Operation activities at the region, zone, and sector levels better reflect the detailed tasks undertaken than operational units. To compare the costs by apportionment with costs through direct measurement, expenditure on operational activities and then to be expressed as costs incurred by operational units. Criteria used to convert expenditures on operational activities to operational units, RaRu(A), ZuZu(A), SaSu(A) have been presented elsewhere (Kaewsonthi 1988). Apportionment, described in Section 3.1.2 must still be used to carry over a proportion of the costs of each operational unit to operational units at a lower level.

The system for measuring the costs of operational activities and subsequently apportioning these costs to operational units is presented in Figure 6.

Figure 6. Systems for Determining the Costs to Operational Units, Activities and Field Services Through Direct Measurement



Expenditure on activities at the Division level was not measured because the effort and cost involved was not justified. It was estimated that only 4% of zone surveillance costs derive from the Division level (Kaewsonthi 1983).

Costs were determined by measuring :
(1) every expenditure and assigning each expenditure to an operational activity;
(2) the proportion of time each person spent on each operational activity;
(3) the consumption of consumable supplies by each operational activity.

3.2 Determining External Costs

External costs are the costs incurred by patients and positive cases seeking diagnosis and treatment and, where appropriate, accompanying relatives (Figure 7). Costs after treatment were excluded from this study.

Figure 7. External Cost Components

Patient(s) (Direct costs)
- expenditure on travelling to the service point (Explicit)
- expenditure on self treatment and drugs (Explicit)
- time.cost (time away from work) incurred when seeking diagnosis (Implicit)
- time cost due to sick leave prior to seeking diagnosis (Implicit)
- time cost between taking a blood slide and the provision of radical treatment (Implicit)

Accompanying relative(s) (Indirect costs)
- expenditure on travelling to and with the patient (Explicit)
- time cost (time away from work) when travelling to and attending the patient (Implicit)

Costs incurred by patients and positive cases are affected by the response made to the services provided and the performance of each service point (time between taking a blood slide and providing radical treatment). The nature, performance and location of services, will affect each patient's response and time costs. Information on the factors affecting patients' consumption of malaria services (Section 4.2.2) was therefore collected together with the information on external costs.

3.3 Relation Between Apportioned and Measured Costs

Procedures were described in Section 3.1 for determining the costs of operational units by apportionment and by direct measurement. Costs determined by these two processes can be used to (1) improve the process of apportionment so that apportioned costs match actual expenditure and (2) improve efficiency in the supply of services and thereby release resources for new projects.

3.3.1 Improving apportionment to match expenditure

If one assumes that measured costs are reliable and accurately reflect what has to be spent in each sector, zone or region, to achieve the recorded performance, then any deviation between apportioned and measured costs shows deficiencies in the criteria of apportionment. Criteria of apportionment can then be modified (as in this study) until apportioned costs match the majority of the measured costs of each operational unit or service.

In practice, a check on expenditure can readily confirm that the costs recorded are reliable. But to assume that expenditure reflects what has to be spent precludes the possibility of any improvement in efficiency. Costs from apportionment can and should be checked against measured costs to ensure there are no consistent or gross errors. But criteria should not be adjusted to match inconsistent cost variations. Such variations are by definition the result of high or low efficiency in specific operations.

3.3.2 Improving expenditure to match apportioned cost estimates

In normal government practice, budgets are indexed in relation to the previous years expenditure. There is, in consequence, little incentive to change practices and no spare resources available for development activities.

If the apportionment process is sound, apportionment provides (1) a rational basis for preparing budgets, and (2) targets by which to improve efficiency.

The rationale for this approach is to be found in the process of apportionment. The total budget from one level is divided among the units at the next level in relation to performance criteria. Two possibilities exist. Either actual expenditure at all units matches expenditure determined by apportionment or, which is more likely, costs are more or less than indicated by apportionment. These deviations from calculated costs, "the norm", can be used to improve efficiency. Any improvement in efficiency would release resources from the budget which could then be used on new projects.

A possible procedure could be:

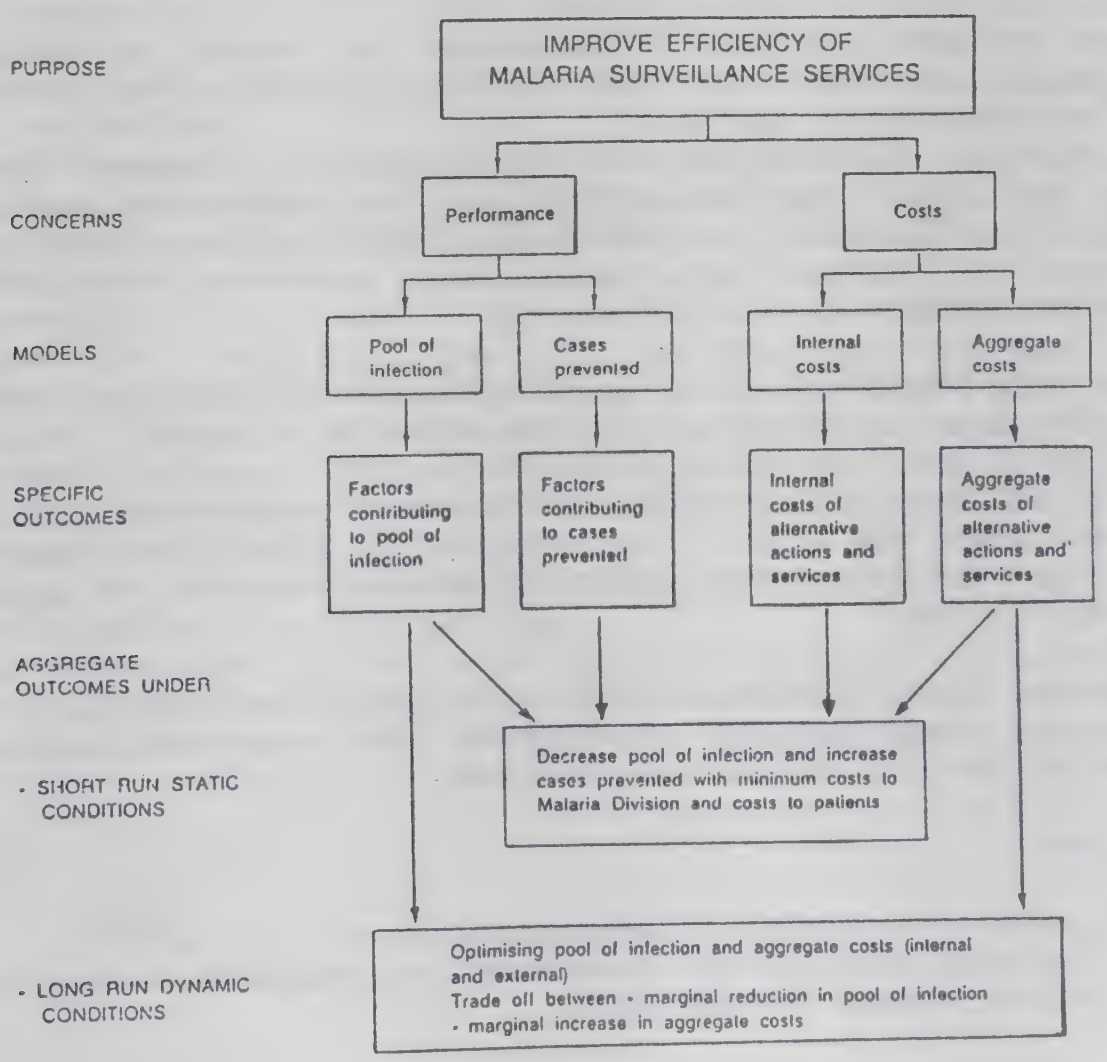
1. those units with expenditure above the "norm" are set targets and their resources progressively reduced;
2. resources released are used by the management on special projects;
3. each unit submits proposals for these special projects;
4. after an agreed time, new budgets are calculated for each unit using the same apportionment criteria. On this occasion a smaller total budget would be used in the calculation so that apportioned costs match the actual costs of the most efficient unit;
5. stages 1-3 are repeated with assistance given in planning the optimal use of resources.

3.4 Improving the Efficiency of Malaria Surveillance Services

Overall performance in a malaria control programme is traditionally expressed as mortality due to malaria and Annual Parasite Incidence rate (API). Surveillance performance is expressed as the Annual Blood Examination Rate (ABER) and Slide Positive Rate (SPR). Performance in vector control is usually described as the number of houses sprayed. These measures are important and yield comforting graphs but may not necessarily lead to the best practice at the lowest costs. A low API could be the result of ineffective surveillance rather than effective control. A study of four villages over 36 days showed that surveillance services only detected 40% of 310 existing cases (Kaewsonthi 1983). A high blood examination rate is not good unless targeted to groups with a high SPR. The number of houses sprayed describes work done but does not measure the effectiveness in vector control or impact on incidence.

Four additional measures were developed through mathematical modelling (Kaewsonthi and Harding 1986) ; the pool of infection, the number of cases prevented, the internal costs of surveillance services, and the aggregate costs (internal and external) of surveillance operations. A further development, not considered at this time, would be to explore the trade off between the pool of infection and costs; to relate marginal decrease in the pool of infection to the marginal increase in costs incurred by the Malaria Division and patients. The relationship among these measurements and models, a framework for improving the efficiency of malaria surveillance operations, is presented in Figure 8.

Figure 8. Framework for Improving Efficiency of Malaria Surveillance Services



3.4.1 Pool of infection model (Appendix 1)

Principles :

The pool of infection (PI) is the infective capacity of a community expressed as the number of mandays per year there are infective carriers. Two major components of the variables are the number of cases (both detected and undetected) and the time between infection and cure (this depends upon patient's performance, services' performance and the response of parasite species to drugs).

Implications :

The pool of infection can be reduced by decreasing parameters with the highest values. The model can be treated as a static or dynamic analysis. As a static analysis, it is assumed that parameters do not change in the short-run. As a long-run dynamic analysis, consideration would be given to changes in parameters and the interdependence among variables. Sensitivity analysis of the relationships can then be made.

3.4.2 Case prevented model (Appendix 1)

Principles :

The efficiency of malaria control processes can be expressed as the costs for detection or for prevention. Costs per case detected suffers from two defects.

(i) Costs per case increases as the number of cases decreases. This situation provides the Malaria Division with a very weak argument for maintenance of services.
(ii) An increase in API may be welcomed because it decreases the cost per case but could not be criticized as reflecting weaknesses in control. Conversely a decrease in API may be a cause of concern because it raises the cost per case or could indicate ineffectiveness in case detection.

Costs per case prevented is, in many ways, a more appropriate measure of performance when considering a communicable disease. Unfortunately, calculation of costs per case prevented is often based on a change in API over a 20-30 year period (Mills 1987). Such projections ignore or make assumptions about the effects that changes in conditions may have on present day incidence and offer little guidance on the management of current operations.

The proposed Case Prevented Model overcomes these problems. The model estimates the cases prevented on a yearly basis by reference to data collected as part of the control programme.

Implications :

The model provides a number of advantages:
(i) It is based upon current measurements (number of positive cases detected through SCD and MBS).

(ii) The preventive performance (cases prevented) of a sector or zone increases as it becomes more effective in case detection through SCD and MBS.
(iii) Preventive performance will be improved by
(a) decreasing the time between taking a blood slide and providing radical treatment;
(b) improving patients' performance (reducing the number of days between the onset of symptoms and seeking care);
(c) increasing case detection effectiveness so that the number of undetected cases decreases.

The model provides the means to monitor the aggregate performance of sectors of zones but not services or service points.

3.4.3 Internal cost model (Appendix 1)

Principles :

The internal cost model can be expressed in relation to a short-run or long-run time scale. Short-run assumes that the budget is constant over the time period. In the long-run cost model, the budget changes over time although some components of the costs (i.e. office buildings) would be fixed over the time period.

Implications :

The pool of infection model coupled with the short-run internal cost model provides guidelines on how to decrease PI having regard to the costs of alternative actions. The following actions are indicated.

1) Increase services where the costs per detection and treatment of cases are minimum.
2) Decrease the number of active carriers who remain undetected each year by increasing the quantity and effectiveness of detection through services where the costs per blood slide examined is minimum.
3) Decrease the number of false negatives through re-training microscopists.
4) Decrease the costs per case for detection and treatment of false negatives and the time between taking a blood slide and providing radical treatment to false negative patients through improved management.
5) Decrease the number of recrudescent Pf and relapsed Pv malaria cases through effective drug therapy.
6) Decrease the average time between taking a blood slide and providing radical treatment by each service.
7) Decrease the number of untreated cases through improved management.
8) Decrease the average time between the onset of symptoms and patients presenting themselves at each service through health education and redistribution of services.

Limitations :

The model is helpful in providing guidance on actions. But it is limited to internal costs and takes no account of the significant costs incurred

by patients (Kaewsonthi and Harding 1986d). The model is also confined to the short-run static condition where parameters and budget are specified and the variables are linearly related. The model presented in 3.4.4 takes account of internal and external costs, the non linear relationship of variables, and allows long-run dynamic analysis of the situation.

3.4.4 Aggregate cost model (Appendix 1)

Principles :

Total Costs to Malaria Division

Total costs to the Malaria Division may not be linearly related to the number of cases. When the Malaria Division increases its surveillance activities there will be fewer cases existing to be detected. The total costs to the Malaria Division therefore increase at an increasing rate. This implies that marginal costs and average costs per case detected eventually increase sharply.

Total Costs to Patients

Total costs to patients, in a very long-run, may not be linearly related to the number of patients. When the Malaria Division increases surveillance activities through more services and shortens the time between taking a blood slide and providing radical treatment, patients performance can be expected to improve. They are likely to present themselves for diagnosis and treatment more quickly after the onset of symptoms. Total cost to patients may be expected to increase at a decreasing rate. This implies that marginal costs and average costs incurred by patients may eventually decrease.

Since non-linear relationship of total costs to patients may exist only in a very long-run (slow changes in behaviour pattern) it is not unreasonable to assume linearity during a period of 1-2 years.

Aggregate Costs of Surveillance

Costs to the Malaria Division and costs to patients should not be treated in isolation but considered as a whole. First, the aggregate cost is the cost to be borne by the community. Second, the Malaria Division is dealing with a communicable disease. Services provided should therefore stimulate an early response by patients. This requires consideration of the effect of services on the costs to patients.

Implications :

Minimum average costs of surveillance can be determined by differentiating the average cost function and set the results equal to zero. Using numerical methods to solve for Nfi and Nvi would then suggest the value of Nfi and Nvi at the minimum average aggregate costs for a given incidence level. Nfi and Nvi are the number of cases which should be detected by service i to minimize average aggregate costs.

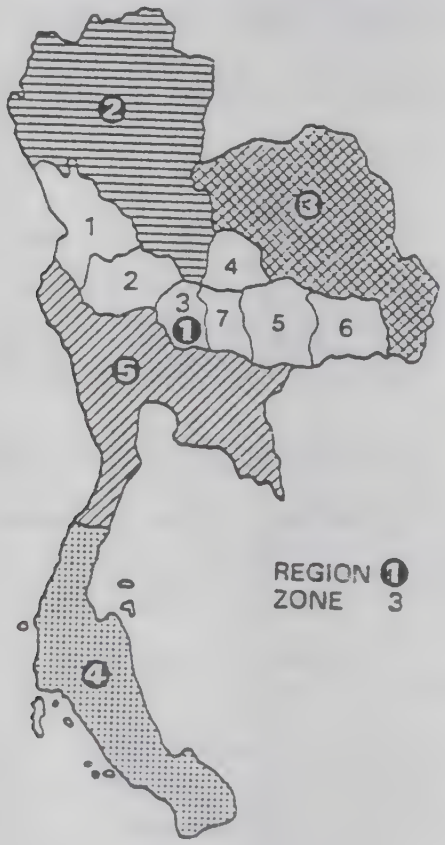
4. RESEARCH PROCESS

Major issues to be resolved in the research were the selection of a study area and sample population, design and execution of surveys and the procedures of analysis.

4.1 Study Area

Zones 3 and 7 in Region 1 (Figure 9) were selected for the study.

Figure 9. Location of Zones 3 and 7 in Region 1



The Region and zones are representative in terms of services, environment and problems. The location was also convenient for regular meetings between the field personnel and the Principal Investigator. Most importantly, the Regional Director at the time, and the zone and sector staff, wanted to participate in the research to see how they could improve performance.

Region 1 is responsible for operations in twelve provinces covering 113,646 square kilometers from Tak province on the Burmese border to Srisaket province, bordering Kampuchia. The population of 10.5 million is distributed among 12 provincial capitals, 138 district towns and 13,911 villages. Of the population 83.4% are in eradication areas and 16.6% in the forested mountain and border areas under malaria control.

Zone 3 Saraburi, is located in Phra Bhuddhabat district between the provincial capitals of Saraburi and Lopburi. Zone 3 is largely a flat plain. Three areas (Lopburi, Kangkoi and Chaibadan) are wooded mountains and have a high incidence of malaria. Only 2% of the population now live in areas where spraying is necessary.

Zone 7 Pakchong, is responsible for malaria operations in six districts of Saraburi and Nakhon Ratchasima provinces. A major obstacle in control of malaria in Zone 7 has been the geography of the area; plains, forested foothills and mountains. Vector breeding sites are widespread, particularly in the fringes of the forested hills. Seasonal agricultural workers and "pioneers" import and export malaria. Positive cases in the population are therefore hard to treat and to follow.

The dynamic nature of the conditions in the study areas (population, malaria situation and services provided) are shown in Figure 10.

Figure 10. Surveillance Statistics : Zones 3 and 7 (1980 and 1986)

Items	Zone 3		Zone 7		Region I
	1980	1986	1980	1986	1986
AREAS : Square km.					
- Total (Square km.)	9,063	9,063	8,122	8,122	113,646
- Control %	46.42	46.42	57.49	57.49	-
- Eradication %	53.58	53.58	42.51	42.51	-
POPULATION					
- Total (All phases)	1,034,369	1,048,606	507,981	597,999	10,463,025
- Control %	13.12	15.67	47.57	49.37	16.61
- Eradication %	86.88	84.33	52.43	50.63	83.39
BLOOD SLIDES TAKEN	65,887	67,158	121,639	158,770	1,028,163
- ABER %	6.37	6.41	23.95	26.55	9.83
POSITIVE CASES	4,969	1,452	11,413	1,358	50,396
- API per 1,000 population	4.80	1.38	22.47	2.27	4.82
NUMBER OF SERVICE POINTS					
- Sectors in the area	8	8	6	6	61
- MC	4	9	7	16	105
- VMV	1,083	1,035	979	1,210	9,611
- VHC	156	198	79	93	1,517
- H	10	17	6	6	116
NUMBER OF VILLAGES					
- Control	209	289	240	348	2,044
- Eradication	1,513	1,582	410	441	11,553

Between 1980 and 1986, the population in Zone 7 rose by 17.7% with a 45% increase in the number of villages in control areas (22% increase in population). At the same time the number of positive cases fell from 11,413 to 1,358 with a marginal increase in the initial high ABER (from 24% to 26%). This dramatic improvement in the malaria situation has been accompanied by a marked increase in the number of service points. This type of change raises important questions about how the Malaria Division should respond to such changes in conditions.

4.2 Surveys

Primary surveys were conducted to determine costs to the Malaria Division (internal costs), costs to patients (external costs) and the performance of surveillance services (time between taking a blood smear and providing radical treatment to positive cases). Each survey is briefly described in sections 4.2.1 - 4.2.3. Results are presented and analysed in Sections 5, 6 and 7.

A key factor in securing reliable data throughout the long period necessary for the study was the commitment and competence of field personnel coupled with regular checking. This was achieved by training, working within the established chain of command and integrating the survey activities in the daily work schedules of personnel. The Regional Director, zone chiefs, assistant zone chiefs and sector chiefs were also involved in the research design and trials.

4.2.1 Internal costs

Expenditure on operational activities at each level was determined over a full financial year through surveys of manpower utilizations, expenditure and the use of centrally purchased supplies.

Manpower - time allocated to activities :

Field personnel and personnel with multiple functions kept a daily diary of time spent on activities. A monthly summary was recorded on form T1 and checked by sector, zone and regional officers.

Expenditure :

Personnel applying for embursement of funds had to specify, on the embursement document, the amount expended on each operational unit or field service with accountants recording the expenditure under appropriate budget headings and activities. A check was also made on the budgets disbursed to the Region and each zone and sector.

Monthly summaries were made of budgets expended.

Forms
- I1 - Budget expended from region to zones and to regional H.Q.
- I2 - Budget expended to operational activities within regional H.Q.
- I3 - Budget expended from zone to sectors and to zone office.
- I4 - Budget expended to operational activities within zone office.
- I5 - Budget expended to field services within each sector and to the sector office.
- I6 - Budget expended to malaria clinics in the area under each zone's responsibility.
- I7 - Budget expended within each malaria clinic.
- I8 - Budget and performance of mobile clinics and special case detection.

Stock and use of consumable supplies

Three major supplies (spraying chemicals, drugs and laboratory supplies) are centrally purchased at the Division HQ. A survey was made of the centrally purchased supplies actually used by (i) stock checks at the beginning and end of the year at sector, zone and regional headquarters and (ii) recording quantities of these supplies disbursed and embursed at each level.

The survey forms were

- S0 - Record of stocks on 1 October 1985.
- S5 - Record of stocks on 30 September 1986.
- S1 - Monthly stock control record of embursements at regional headquarters and zones.
- S2 - Monthly stock control record of embursements at zone headquarters and sectors.
- S3 - Monthly stock control record of embursements at sector office and operational services.
- S4 - Monthly stock control record of embursements by service points.

The System allowed for checking at each stage.

4.2.2 External costs

Patients were interviewed using structured questionnaires to gather data on costs and patients' behaviour in consumption of malaria services (Figure 11).

Figure 11. Information Collected on External Cost and Patients' Behaviour in the Consumption of Malaria Services

Personal	– name, age, address, sex, education, occupation
Patients' behavior in consumption of services	– distance to service point, – reasons for attending the service if not the nearest point to home – reasons for having blood checked – means of travel.
Patients' performance	– days with illness before seeking diagnosis
Costs incurred by patients	– explicit (travel and drugs) – implicit (time cost)
Costs incurred by relatives attending patients	– explicit (travel cost) – implicit (time cost)

The purposes of each questionnaire, period of survey, sample size and description of personnel conducting interviews are shown in Figure 12.

Figure 12. Collection of Data on External Costs

Questionnaire	Data gathered	Period of survey sample and season	Services (interviewers)
E1 E2	- patients' background - patients' behaviour in consumption of service - costs incurred by patients - costs incurred by relatives - patients' performance	1-30 Nov 85 (dry) (n = 3,832) 1-28 Feb 86 (dry) (n = 6,663) 1-31 May 86 (dry) (n = 4,987) 1-31 July 86 (semiwet) (n = 5,731) 1-31 Aug 86 (wet) (n = 4,165) 1-30 Sept 86 (wet) (n = 2,212) 1-31 Oct 86 (wet (n = 1,580)	all MC (n = 24) all MMC (n = 5) 50% VHC (random selection) (n = 130) 30% VMV (random selection from active volunteers (n = 550) all ACD house visitors (n = 55) all SCD personnel (n = 14)
E1M E2M	As E1 and E2 with the addition of questions concerning labour substitution	1 Aug - 31 Oct 86 (n = 2,875)	

4.2.3 Performance

Performance factors of significance in the current study, evident in the pool of infection model and cases prevented model, (Section 3.4.1, 3.4.2) are listed in Figure 13 together with sources of data and the sample size.

Figure 13. Collection of Data on Performance Factors

Performance factors	Sources of data	Sample size (n)
Numbers - cases detected by each service	Direct collection from surveillance report of service units (Epidemiology report No.2) during financial year 1986 (1 Oct 85–30 Sept 86)	
- cases detected which did not receive radical treatment - recrudescence and relapsed cases detected and treated	Epidemiology report No.2+6 during financial year 1986	
- undetected asymptomatic cases - undetected sypmptomatic cases	Extrapolate from primary surveys undertaken in previous study (Kaewsonthi 1984)	
- total number of false negatives determined by rechecking a sample of reported negative blood slides	Laboratory report (LS) No. 8 during financial year 1986	
Times - average between onset of symptoms and patients seeking treatment for each service	Primary survey of patients attending services (E1, E2, E1M, E2M)	n = 29,170
- average between taking a blood slide and provision of radical treatment for each service	Epidemiology report No 6 during financial year 1986	n = 1,512
- average between taking a blood slide and treatment of recrudescent cases	Epidemiology report No 6 in conjunction with interview of zone and sector chiefs	n = 16
- average between taking a blood slide and provision of radical treatment for false negative cases	Survey of positive cases identified by rechecking and Laboratory re–checked form LS 10	n = 1,667

4.3 Data Encoding and Analysis

Computer programmes for encoding and analysis were designed so that they could be used subsequently by the Malaria Division. Menus and instructions were written in Thai.

4.3.1 Internal costs

Manpower (Time analysis)

Two programmes were developed. The first programme records name, age, sex and position of personnel, together with their basic salary, annual increments, qualifications, task description and station of operation. Data can be analysed to show the personnel profile by category for each operational unit and service at each level.

The second programme allows for encoding of data from monthly summaries of daily activities (T1 forms) and analysis of the time spent on each activity by type of personnel and grade, aggregated at sector, zone and regional level.

Expenditure (Financial control)

Programmes allow for budgets and monthly embursement reports to be encoded and analysed to show distribution of budgets, dis-bursements and residual balances under each budget heading. This analysis can be made for each operational unit at the division, region and zone levels. Expenditure by each field service can also be analysed by component costs.

Stock and use of consumable supplies

Programmes for encoding and analysing data on the use of consumable supplies (S forms) provide position statements on purchase, disbursements and stocks at each level. Purchase and disbursement of materials is a direct cost which is allocated to a specific activity, unit or service.

4.3.2 External costs

Two sets of programmes were written to allow encoding of service performance (Epidemiology Report No. 6) and data from surveys of patients with analysis by services in each sector, by sector, by zone and where appropriate, by season.

Major analyses from the survey of patients were :

1. Frequency distribution for non ratio scale responses.
2. Frequency distribution, mode, mean and standard deviation for ratio scale responses (expenditure, distances, etc.).
3. Cross tabulations to determine the extent of relationships among variables.
4. Costs to patients, direct, indirect, implicit and explicit.

5. INTERNAL COSTS

Results of measured and apportioned costs are presented and analysed in four sections.

1. Surveys :
   Results of primary surveys, analysis of the quality of these data and the effects of quality on cost analysis.

2. Apportionment vs measurement :
   Comparison of sector operational unit costs at zone and divisional levels.

3. Costs and performance of sectors :
   Comparison of sector surveillance and vector control costs in relation to performance.

4. Costs and performance of field services :
   Comparison of the performance, and the costs to performance ratio of field services, and a study of malaria clinics.

In addition to its budget the Malaria Division secures a variety of support from external agencies in the form of grants, manpower and materials on an ad hoc basis (6.3 million Baht or 2.2% of the Divisional budget in 1986). This was not included in the study.

5.1 Surveys

In 1986, 66.7% of the Malaria Division budget was assigned to manpower, 15.3% to centrally purchased supplies, and 18.0% to other budget headings. The quality of manpower surveys therefore has a major effect on the reliability of measured costs.

5.1.1 Manpower

The time of personnel with a single function was assigned to their given activity. Time distribution of personnel with multiple functions was determined through daily diaries (Section 4.2.1). When linked with salaries and wages (expenditure survey) this yielded the time cost component for each operational activity and field service in each sector. The time distribution of salaried government officers and permanent wage employees in the two zones, is summarized in Figure 14. Temporary wage employees (10% of manpower costs) is not shown in Figure 14 because their time is assigned to specific activities such as spraying.

In some cases over 50% of a person's time was unclassified. This raises three questions :

1) How should this unclassified time be assigned to activities?
2) How reliable are the data?
3) What are the implications?

Assignment of unclassified time

Unclassified time can not be ignored when costing activities. It is part of the input capacity. It was, therefore, distributed (for each respondent) in proportion to the time which was already assigned to activities. This raises the costs of activities.

Reliability of data

No real measurement of reliability could be made but two factors gave some confidence in these data : (1) little attempt was made to hide the large proportion of unclassified time which appeared in personal diaries such as "talking with colleagues, entertaining friends and rainy days not suitable for work" ; and (2) the consistency of individual responses (time for a similar activity) was checked and explanations sought for discrepancies.

Implications

Unclassified time is potentially inefficient use of time. This issue was reviewed by the Malaria Division.

5.1.2 Centrally purchased supplies

Centrally purchased supplies are the materials purchased by the Malaria Division headquarters which are then disbursed to regions, zones and sectors. Major components in consumable supplies are spray chemicals, drugs and laboratory supplies. In 1986, the Division spent 15.3% of its budget on the purchase of new supplies of these materials and also received additional free supplies of spray chemicals and drugs from national and international agencies.

Embursement and consumption of centrally purchased supplies was determined through secondary surveys of the Malaria Division records and through primary surveys (Section 4.2.1). Each level (Division, region, zone, sector, field post) hold stocks. Requests for additional supplies are submitted to the next level. There is no financial transaction between levels but records of quantities disbursed and embursed are kept at each level. To determine the costs of spray chemicals and drugs, quantities were converted into money terms using F.O.B. prices provided by the Malaria Division.

Malaria Division records showed major discrepancies between what is disbursed, embursed and held in stock. Primary surveys, though thoroughly checked, also showed inconsistencies in responses such as zero stocks which resulted in marked discrepancies with zone records.

Inconsistencies in these data are a cause for concern both for the Malaria Division's operations and for the cost analysis. The Malaria Division is examining its operations. Use of the computerized monitoring system, developed for the project, could help to improve accuracy of records and facilitate cross checking between disbursement and embursement at each level. For the costing analysis a more fundamental approach had to be taken based upon estimated costs of necessary consumption (Section 5.2.2).

5.1.3 Expenditure on activities and field services

Expenditure under each budget heading, excluding centrally purchased supplies, was monitored and the costs assigned to relevant activities and field services. This included the salaries of personnel which, when related to the mandays spent on activities, yielded a manpower cost for activities and services. The results from these surveys provided the input information for calculating the total costs of activities and services. The costs of the centrally purchased supplies had to be determined through an estimated need for necessary consumption (5.2.2).

Considerable confidence can be placed in the quality of expenditure data. Internal checks were made between levels to ensure that expenditure to activities or services and any budget transferred to a lower level was consistent with the budget received.

5.2 Apportioned versus Measured Costs

Apportionment is the allocation of available resources to activities, units and services. If based upon readily available data, apportionment could provide the Malaria Division with a simple means to determine operational costs.

Comparison was made of measured and apportioned costs of (1) sector operational units (excluding centrally purchased supplies, and (2) centrally purchased supplies,

5.2.1 Costs of sector operational units

Apportioned and measured costs of sector operational units in Zones 3 and 7 were compared at the zone and Division levels. Statistical test of differences showed no significant difference at the 95% confidence limit between apportioned and measured costs. This suggests that both the criteria used in the apportionment of sector costs and the measurement process are sound.

Criteria used in the apportionment can therefore be used as an alternative to the expensive and time consuming process of measurement.

5.2.2 Costs of centrally purchased supplies

Comparison of apportioned and measured costs in the use of chemical spray, drugs and laboratory supplies, though possible in theory, was impossible in practices (5.1.2).

Division, region and zone records of disbursements and stocks were inconsistent and primary surveys yielded unrealistically high or low values in relation to estimates of needs.

An alternative approach was therefore developed using criteria to determine Estimated Costs of Necessary Consumption (ECNC); the quantity of chemical spray in relation to the number of houses sprayed, quantity of drugs in relation to number and type of positive cases and the quantity of laboratory supplies in relation to the number of blood slides (Kaewsonthi 1986). This estimate provides a convenient basis for monitoring consumption in relation to the Malaria Division's records.

5.3 Costs and Performance of Zones and Sectors

Sectors and zones are the management levels which provide antivector and antiparasite services to the public. Comparison between sectors and zones of costs and suitable costs/performance measures should, therefore, provide a basis for improving efficiency in the delivery of services.

5.3.1 Costs

A number of conclusions can be drawn on analysis of the operational unit costs (at Division level) for each sector in the two zones (Figure 14).

1) Average operational unit costs are between approximately 200 to 420 million Baht.
2) Significant variations in costs occur among sectors in the same zone (S.D. is between 0.14 to 0.49 of the average costs).
3) Average sector operational unit costs in zone 7 are about 60% higher than zone 3.
4) On average 82.9% of sector operational unit costs (at the Division level) are incurred at the sector and zone levels (Figure 14). Only 12% is incurred at the Region and 5.1% at the Division level.

However, these costs have limited meaning unless related to some measures of performance. But which measures provide the best criteria for management when related to costs. Several performance measures are examined below. Sector costs are expressed at the zone level.

Figure 14. Average Contribution to Sector Operational Unit Costs From Zone, Region and Division H.Q.

Sector Operational Units	Av.% Contribution to Sector costs From			
	Sector	Zone	Region	Division
Vector Control	34.2	40.4	17.4	8.0
MC and Lab	69.9	18.9	7.9	3.3
Epi and Eval	57.6	23.9	13.4	5.1
T O T A L	57.0	25.9	12.0	5.1

5.3.2 Costs and performance in surveillance

1. Costs / person
[(MC/Lab) + (Epi/Eval) + (ECNC)] / population.

Costs/person : zone 3, 3.4 Baht; Zone 7, 6.8 Baht.

Costs/head protected is a convenient concept in the general computation of programme costs but takes no account of work undertaken or the effectiveness of that work. Nor does costs/head offer a real basis for improving efficiency.

2. Labour costs / material costs ratio
[(Total cost of surveillance) - (ECNC)] / (ECNC)]

Ratio : zone 3, 37.8; Zone 7, 15.0

Material costs (ECNC) reflect the case load of a sector. The labour/material costs ratio therefore indicates the level of operational efficiency in case detection and treatment.

This ratio would appear to be a useful management tool. For example, labour efficiency for surveillance in Zone 7 is double that of Zone 3 and shows much less variation among sectors. However, the ratio must be used with caution. Examining a large number of blood slides will reduce the labour/material costs ratio. But if the SPR is very low, the value of the work should be questioned.

3. Costs / blood slide (excluding slides taken and examined by the hospital service)

Costs / blood slide : Zone 3, 87.2 Baht; Zone 7, 27.3 Baht.

This ratio is of limited value since a low costs / blood slide could be the result of a large number of slides or a small labour input for slide collection and examination.

4. Costs / positive case (excluding cases detected by the hospital service)

Costs / positive case : Zone 3, 3,442 Baht; Zone 7, 3,310 Baht.

The costs / positive case highlights any gross inefficiency in the use of manpower in surveillance. But the number of cases detected and therefore the costs / case is also affected by factors outside the control of the Malaria Division.

Uncertainty in interpreting the costs per blood slide emphasises the need to consider alternative measures in expressing the surveillance efficiency of sectors and zones.

5.3.3 Costs and performance in vector control

1. Costs / person
[(Total costs of H.Ed.+VC+ENT) / (population in control phases)].

Costs / head : Zone 3, 10.8 Baht; Zone 7, 10.9 Baht.

This measure provides limited guidance in management.

2. Labour / material costs ratio

Ratio : Zone 3, 5.0; Zone 7, 2.1.

Zone 3 shows a high labour / material costs ratio for vector control similar to surveillance (5.3.2) and a wide range among sectors (infinity in one sector where no houses are sprayed).

3. Costs / house sprayed

Costs / house sprayed : Zone 3, 178.8 Baht; Zone 7, 76.3 Baht.

This is a useful indicator for management and for cost estimation. Costs include the costs of Vector Control, Health Education, and Entomology units, pray chemical and administration from the zone headquarters and the sector office.

5.3.4 Costs and performance in surveillance and vector control

Total labour costs / total material costs ratio.

Ratio : Zone 3, 13.5; Zone 7, 4.7.

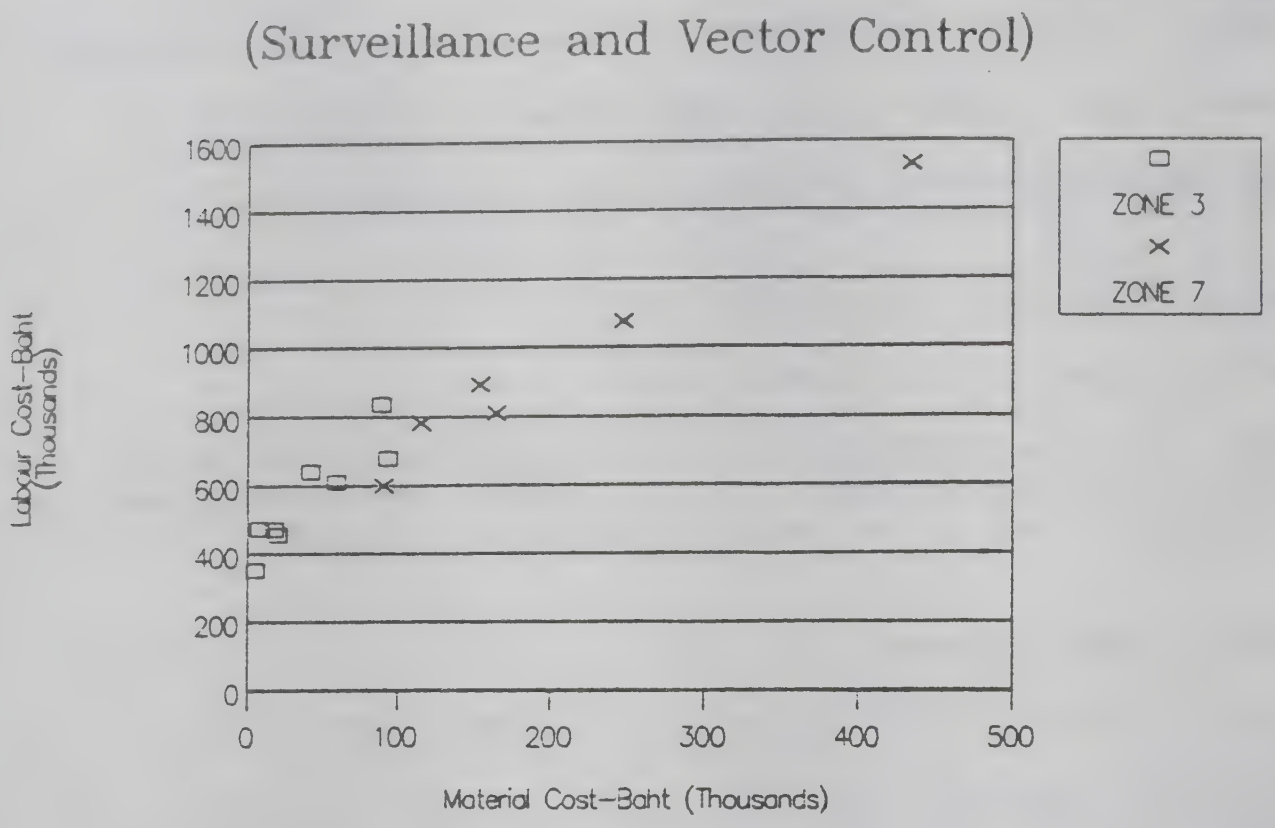
The gross labour / material costs ratio reflects efficiency in utilization of labour and is a useful indicator. A graph of total labour costs vs total material costs (Figure 15) shows two distinct curves for Zones 3 and 7.

5.4 Costs and Performance of Field Services

Field services are the "front end" of the Malaria Division providing services directly to the public. The overall costs and performance of these field services determine, in large measure, the efficiency and effectiveness of control.

This section (1) examines the surveillance performance of field services, (2) reports the relation between the supply (costs in the provision of each type of service) and performance (blood slides taken and positive cases treated), and (3) presents a special study of Malaria Clinics.

Figure 15. Total Labour vs Material Costs



5.4.1 Performance of surveillance services

Total consumption of surveillance services (blood slides taken and positive cases identified), the market share (proportion of consumption) by types of services and performance of individual service points is a product of three factors; supply, demand, and the agency relationship (relationship between a consumer and an authority who may decide if a consumer needs to consume the services provided). Factors affecting supply and demand are;

Supply side
- types of services provided
- number of each type
- location of each service point
- attitudes of personnel (staff), performance of each service type and service point in the provision of treatment

Demand side
- patients' knowledge and behaviour
- incidence and the pool of infection

In the case of outreach services (ACD, SCD, FU, CI and FI), consumption is largely generated by the supplier. The supplier selects locations, possible patients and provides the inducement of a free service. Consumption is mediated, to some extent, by each patient's response to questions and willingness to provide a blood sample. In the case of passive services (MMC, MC, VHC and VMV) consumption is generated by the consumer also in response to a free service. The relation between patients' behaviour and the consumption of services at passive service points is examined in Section 6.

Hospitals, as a passive service, can play a major role in case detection and treatment of malaria. In Zone 3, 35% of all blood slides and 28% of the positive cases are handled by the 17 hospitals. In Zone 7, 6.4% of blood slides and 9% of positive cases are handled by the 6 hospitals. Although the blood slides and positive cases appear in the records of the Malaria Division, little costs accrue to the Division. Hospital statistics are not included therefore when considering the performance of the Malaria Division.

Performance of services on the supply side can be expressed in terms of;

- consumption and market share
- consumption per service point
- time between taking a blood slide and providing radical treatment
- performance in providing radical treatment

Consumption and market share

Consumption and market share of service in 1986 is compared with the results for 1980 in Figure 16.

Figure 16. Relative Contribution of Services in Zone 3 and 7 (1980 and 1986)

(Hospitals excluded)

	1986						1980			
	Zone 3			Zone 7			Zone 3		Zone 7	
	Relative Cont.		SPR	Relative Cont.		SPR	Relative Cont.		Relative Cont.	
Service	Sl.	Pos.		Sl.	Pos.		Sl.	Pos.	Sl.	Pos.
ACD	8.5	0.2	0.05	12.7	2.1	0.10	30.2	2.9	47.4	17.0
MMC	0.7	0.2	0.57	0.9	0.1	0.10	1.0	0.6	2.2	1.8
MC	18.9	84.3	10.70	7.9	68.5	7.00	24.0	81.1	19.6	58.2
VHC	17.2	5.7	0.80	5.6	8.1	1.20	11.1	4.0	4.9	4.8
VMV	33.5	8.2	0.58	6.6	12.8	1.60	27.5	10.7	14.4	14.9
SCD	18.8	1.4	0.17	65.7	7.0	0.10	0.0	0.0	0.0	0.0
FU	0.0	0.0	0.00	0.0	0.0	0.00	0.6	0.0	0.3	0.0
CI	2.4	0.0	0.00	0.6	1.4	2.00	5.1	0.0	6.0	0.0
FI	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0
Others	0.0	0.0	0.00	0.0	0.0	0.00	0.5	0.7	5.2	3.3
n =	43,646	1,046	3.30	148,642	1,224	0.90	42,390	3,543	125,919	11,488

The major features in market share are :

1986 :

- SCD in Zone 7 secured 65.5% of blood slides compared with 18.8% in Zone 3
- VMVs in Zone 3 secured 33.5% of blood slides compared with 6.6 in Zone 7
- MCs made a significant contribution to positive case detection; 84.3% in Zone 3 and 68.0% in Zone 7
- FU, CI and FI make very little contribution to blood slides and positive cases.

1986 compared with 1980 :
- a marked reduction in ACD blood slides; 30.2% to 8.4% in Zone 3 and 47.4% to 12.7% in Zone 7
- a dramatic increase in SCD blood slides; 0% to 18% in Zone 3 and 0% to 65.6% in Zone 7.

Treating all services together in this way fails to differentiate between consumption primarily induced by the supplier and that induced by the consumer.

When passive services are considered separately, differences in the market share among the services become less marked and a clearer picture emerges of the changes between 1980 and 1986 (Figure 17).

Figure 17. Performance of Passive Services (1980 & 1986)

	1986				1980			
	Bl. Slides		Positives		Bl. Slides		Positives	
	% of total	No	% of total	No	% of total	No	% of total	No
Zone 3	70.3	30,688	98.5	1,030	63.6	26,960	96.4	3,415
Zone 7	21.1	31,357	89.4	1,095	41.1	51,753	79.7	9,156

In both zones, passive services increased their market share of positive cases (96.4% to 98.5% in Zone 3 and 79.7% to 89.4% in Zone 7). This was achieved with a marginal increase in the number and market share of blood slides in Zone 3 but a dramatic fall (41.1% to 21.1%) in Zone 7 because a large number of slides were collected through SCD.

The performance of outreach services, in terms of API and SPR, does not match that achieved by passive services. Expressing cases detected by passive services in each zone in relation to the population yields a passive service 'API' of 1.4/1,000 for Zone 3 and 2.1/1,000 for Zone 7 (hospitals have to be included). Treating the blood slides secured by outreach services as a sample population and relating the number of cases detected to the number of patients yields an 'API', for this sample, of 1.2/1,000 for Zone 3 and 1.1/1,000 for Zone 7. Since ACD and SCD should be undertaken in areas with a high incidence it would seem that outreach services are not operating very effectively.

Performance per service point

Performance per passive service unit is of the same order of magnitude for similar types of service in the two zones. However, the average number of blood slides at each VHC point in Zone 7 is twice that of Zone 3. MCs in Zone 3 also detected twice the average number of cases than MCs in Zone 7 (Figure 18).

Figure 18. Average Performance of Service Points

Services	Zone 3			Zone 7		
	Number of units	Bl.Slides / unit	Positives / unit	Number of units	Bl.Slides / unit	Positives / unit
MC	9	914.2	98.0	16	739.1	52.4
VMV	1,035	14.1	0.1	1,210	8.2	0.1
VHC	198	37.8	0.3	93	89.4	1.1
H	17	1,383.1	23.9	6	1,688.0	22.3

Time between taking a blood slide and providing radical treatment.

This time affects the pool of infection (potential for transmission), influences patients' behaviour and has a bearing on patients' costs. A significant improvement in performance occurred in both zones between 1980 and 1986 (Figure 19).

Figure 19. Average Time Between Taking Blood Slides and Providing Radical Treatment (1980 and 1986)

		Average Time (days)					
		MC	VHC	VMV	ACD	SCD	H
Zone 3	1986	1.0	7.7	7.2	6.7	5.0	2.3
	1980	1.3	13.8	11.1	15.9	-	8.8
Zone 7	1986	1.0	7.0	5.1	6.1	6.1	2.2
	1980	1.2	8.4	7.8	8.1	-	5.9

(Source for 1980 data : Kaewsonthi and Harding 1983)

While the improvement is to be welcomed, several features of the 1986 data are not fully explained. There are considerable discrepancies between the number of positive cases detected in each zone [Epidemiology Report form No.2] and the number of cases receiving radical treatment in each zone [Epidemiology Report form No.6]. Only 58% of the positive cases recorded in Epi Rep. No.2 appear in Epi Rep. No.6 which records the time between taking a blood slide and providing radical treatment.

The Malaria Division reports that positive cases are treated in the zone in which they live. The 'missing cases' are cases which live and are therefore registered in another zone. Information is posted to appropriate zone offices. This means that some zones could have more cases registered in Epi Rep. No.6 than Epi. Rep. No.2. It also raises questions about API in each zone.

Performance in providing radical and presumptive drugs

The overall picture for Region 1 shows 44,150 positive cases (excluding hospitals) with radical treatment dispensed to 36,625 patients (90%). Percentages for Zone 3 are 140% and Zone 7 90%.

The percentages for zones mask considerable variations among sectors within each zone (50% to 170%). Assuming reported values are correct, radical treatment drugs are being dispensed to some patients who are not confirmed as positive.

Performance in dispensing presumptive treatment (PT) shows considerable variation as a result of pressure to reduce widespread use of presumptive treatment. Presumptive treatment was given to 40.7% of patients in the Region, 20.6% in Zone 3 and 34.1% in Zone 7. Control in dispensing presumptive treatment appears to be much tighter in Malaria Clinics where only 0.1% of patients received PT in Zone 3 and 6.2% in Zone 7.

5.4.2 Costs and performance of field services

A summary of the costs and performance of field services (Figure 20) shows the main features but masks the range of costs among sectors.

Figure 20. Costs and Performance of Field Services at Zone Level

Zone 3 Costs	ACD			MMC			MC		
		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case
No. Blood slides No. P. Case	417511 3695 2	113.0	208755	28931 314 2	92.1	14465	546813 8228 882	66.5	620
	VHC			HOSP			VMV		
		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case
No. Blood slide No. P. Case	350056 7491 60	46.7	5834	54702 23512 406	2.3	135	1222834 14635 86	83.6	14219
	SCD			FU			CI		
		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case
No. Blood slide No. P. Case	938352 8225 14	114.1	67025	24790 11 0	2253.6	inf.	25469 1047 0	24.3	inf.
Zone 7 Costs	ACD			MMC			MC		
		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case
No. Blood slides No. P. Case	296417 18319 26	15.8	11401	38639 1345 1	28.7	38639	1288303 11826 838	108.9	1537
	VHC			HOSP			VMV		
		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case
No. Blood slide No. P. Case	121740 8312 99	14.6	1230	570 10128 134	0.1	4	774622 9874 154	78.5	4934
	SCD			FU			CI		
		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case		Cost / Bl. Sl.	Cost / Case
No. Blood slides No. P. Case	1455501 97635 86	14.9	16924	6383 0 0	inf.	inf.	39218 1006 17	39.0	2307

At field level, costs are very much influenced by management practices - notably the time cost assigned to services. Costs per unit output is further affected by the effectiveness of each service in the collection of slides and detection of positive cases (market share). Given flexibility in the numerator and denominator, one must look carefully to identify fundamental causes for difference.

A number of interesting features emerge :

Passive Services (VHC, VMV, MC, MMC)

1. Costs / blood slide

(i) VHCs - These services have the lowest costs / blood slide (14-47 Baht). Since VHCs are not funded by the Malaria Division, costs are largely time costs arising from the collection of blood slides and distribution of radical treatment to positive cases. For a similar number of slides, costs in Zone 3 (47 Baht) are three times the cost of Zone 7 (14 Baht).

(ii) VMVs - VMVs have a similar costs / blood slide in both zones (80 Baht). VMVs receive no payment for their services. Like VHCs, their slides are collected and examined at an MC, with radical treatment dispensed through the zone office. The higher costs/blood slide (relative to VHC) probably arises because (1) extensive travelling is required to isolated service points (even inactive volunteers require regular visiting) and (2) the small number of blood slides collected.

(iii) MCs - There is a significant difference in costs / blood slide between the zones; 66.5 Baht (Zone 3) and 108.9 Baht (Zone 7). Costs / slide in this case only refers to the patients who called at the clinic for diagnosis. The average operational costs of malaria clinics, at the clinic level (Section 5.4.3), is 36.9 Baht per patient (Zone 3) and 39.4 Baht (Zone 7). When expressed at the zone level, costs rise to 66.5 Baht (Zone 3) and 108.9 Baht in Zone 7. This rise, particularly in Zone 7, is due to the time cost associated with the delivery of slides to clinics and zone supervision of the clinics.

(iv) MMCs - Mobile Malaria Clinics have low costs / slide because a large number of slides are collected during each visit.

(v) H - Costs incurred in the handling of statistical data from hospitals are negligible.

2. Costs / positive case

Costs / positive case are affected by the time and materials costs of each service and performance in attracting positive cases (market share of positive cases). MCs, H and VHCs have the lowest costs / positive case. MCs have a low costs / case because of the large number of positive cases. Hospitals and VHC have a low costs / case because they are funded by other departments of the MOPH.

Outreach Services (ACD, SCD, FU, CI)

1. Costs / blood slide

ACD and SCD. - The costs / blood slide of these services are very similar among sectors within each zone but very different between the two zones; 15 Baht (Zone 7) 113 Baht (Zone 3). Given the large number of slides taken by Zone 7, one can only assume that they are more effective in securing slides and more efficient in the management of staff time.

FU and CI. - These activities have surprisingly low costs and in consequence a low costs/slide. The large number of CI in Zone 3 arise because cases detected through MBS are included.

2. Costs / positive case

The low SPR of ACD and SCD results in the extremely high costs/ positive case for these services.

Since FU and CI identified zero positive cases the costs / positive case are listed as infinity.

The low SPR of outreach services suggests that greater efforts could be made to select areas and develop practices which improve the detection of positive cases.

5.4.3 Malaria clinics

Malaria clinics serve two purposes (1) to act as a service point for patients seeking diagnosis and treatment and (2) to examine blood slides provided through other services. In 1986, malaria clinics examined 90% of all blood slides in Zone 3 and 80% in Zone 7. Of these slides, only 21% (zone 3) and 10% (Zone 7) were from clinic patients.

Malaria clinics are a key element in surveillance. Growth in the number of clinics between 1980 and 1986 reflects recognition of the value of these service points (4 to 9 clinics in Zone 3 and 7 to 16 clinics in Zone 7). But are all the existing clinics both effective and efficient? When should this increase in the number of clinics stop?

The average costs, performance and cost/performance relationships for the MCs in the two zones are presented in Figure 21.

Figure 21. Costs and Performance of Malaria Clinics

	Zone 3	Zone 7
Average costs per		
- Clinic	33,707 B	29,103 B
- Staff member	23,800 B	22,300 B
Percentage of total costs (at field level)		
- Labour	86.2 %	86.1 %
- Med. supplies	6.5 %	6.1 %
- Lab. supplies	7.3 %	7.8 %
Percentage of time to		
- Clinic patients	37.5 %	18.6 %
- Service slides (based upon x = 2.2 y)	62.5 %	81.4 %
Local average costs (Total costs in relation to clinic patients)		
- Per clinic patients	36.9 B	39.4 B
- Per positive cases	343.9 B	555.7 B
- Lab supply / slide	0.6 B	0.3 B
- Med supply / positive	22.4 B	33.7 B
Overall average costs (Total costs divided in relatian to time on clinic patients and service slides)		
- Per clinic patient	13.8 B	7.3 B
- Per positive cases	128.9 B	103.4 B
- Per service slide	6.2 B	3.6 B

Average costs of clinics

The average costs of clinics in Zones 3 and 7 is 31,000 Baht/ year; 86% of costs are labour, 6.1% - 6.5% medical supplies and 7.3% - 7.8% laboratory supplies.

Performance

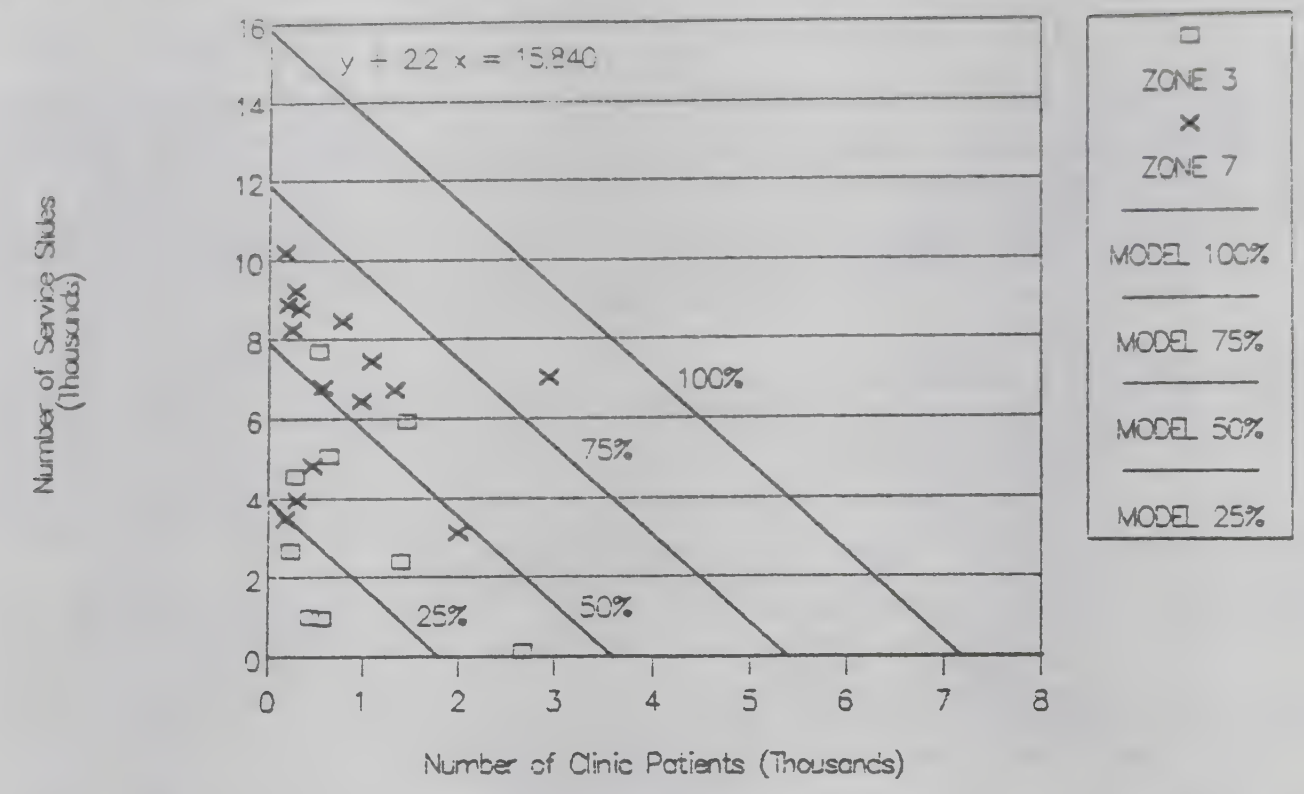
Two questions present themselves :
- What is the maximum case load per microscopist in a clinic?
- What is the performance of clinics with respect to this case load?

If it is assumed that a microscopist can, (1) examine 60 blood slides / day, when collected by other services or (2) handle 27 clinic patients / day. That it takes 25 minutes to interview positive cases and the SPR is 10. Then, the maximum case load is determined by the equation $k = 2.2 x + y$

where $k = 15,840$
$y =$ number of service slides / year
$x =$ number of patients.

The actual case load of malaria clinics / staff member is plotted in Figure 22 together with curves for the percentages of capacity.

Figure 22. Case Load of Malaria Clinics



Based upon the maximum cases load 50% of clinics operated at less than 50% capacity.

Average costs per patient or positive case

When the costs of malaria clinics are assigned only to clinic patients, average costs/patient are 37 Baht in Zone 3 and 39 Baht in Zone 7. When clinic costs are assigned to positive cases seeking treatment at the clinics costs/positive case are 344 Baht in Zone 3 and 556 Baht in Zone 7. The marked difference between the zones is due to the SPR of 7 in Zone 7 and 11 in Zone 3.

Average costs per patient, positive case and service slide

When the total costs of malaria clinics are divided in proportion to the relative time required for patients (x) and service slides (y), more appropriate costs emerge; 7 to 14 Baht/clinic patient, 103 to 130 Baht/clinic positive case and 4 to 6 Baht/service slide. A large service load in Zone 7 reduces the proportion of costs assigned to clinic patients and reduces the costs/patient and costs/case relative to Zone 3. In principle, the costs/service slide should be transferred to the service from which the slides originate.

At full capacity, based upon the average costs per clinic and the maximum working capacity, the minimum costs/service slide at malaria clinics will be # 2.0 Baht/slide, the minimum costs/clinic patient 4.4 Baht/patient and the minimum costs/positive case 44 Baht. These costs are at the clinic (field level) and neglect the costs in gathering the slides, zone supervision and "overheads" from the Region and the Division. This analysis reveals how the capacity of clinics has to be linked to the performance of other services if the efficiency of all surveillance services is to be improved. It may now be possible to develop a production model, on the supply side, which takes into account the costs and performance of each type of service.

6. BEHAVIOUR OF PATIENTS IN SEEKING CARE

The behaviour of patients in seeking diagnosis and treatment at particular passive service points or responding to outreach activities is a product of many factors: (1) attitude and response to symptoms and conditions which could indicate a malaria infection; (2) knowledge about malaria and alternative services; (3) convenience, time, distance and costs of travel to service points; (4) family circumstances (5) the performance of service points (time between taking a blood slide and providing radical treatment); and (6) the attitude and response of Malaria Division staff at service points.

Outreach services mediate normal consumer behaviour by seeking patients. Taking a blood sample is a free service. Giving the blood sample takes little time and offers an opportunity to talk with someone from outside the village. Potential patients know the date of ACD visits well in advance and can choose, in relation to symptoms and conditions, whether to wait for an ACD visitor or to seek treatment at passive service. For SCD, little advance notice is given (1-2 days) and the service effectively samples from the population who happen to be present at that time.

In managing the number, type, location and performance of services, the Malaria Division can affect patient behaviour and costs to patients (Section 7). This section reports some aspects of patients' behaviour and attempts to explore possible implications for the Malaria Division in the management of its services.

It is relatively easy to describe the characteristics and behaviour of a community. Explaining the causes of the behaviour, how conditions relate to behaviour and predicting how changes in conditions may modify behaviour, is more problematic. Descriptions at one point in time without the understanding derived from monitoring the interplay of behaviour and conditions over a long time period, provide little basis for modelling and assessing future scenarios.

Findings are presented in four sections :

1. The sample population - number of patients and positive cases, services used, age, sex, occupations, education and family size.
2. Behaviour - reasons for seeking care, reasons for not attending the nearest service point and actions taken before attending this service to treat this fever.
3. Travel - distance to nearest service point, distance from home to the service point attended and means of travel.
4. Implications.

6.1 The Sample Population

Numbers :

The behaviour of patients in seeking care was surveyed over seven one-month periods (Section 4.2.2). The number and proportion of patients and

positive cases attending each service is presented in Figure 23. Within the period of the survey, 37.2% of the total sample population (Zone 3 plus Zone 7) attended a passive service point. This was 72% of the patients in Zone 3, but only 20% in Zone 7. The latter, low figure, was due to extensive outreach activity (ACD and SCD) in Zone 7. Some 98% of positive cases attended a passive service point in Zone 3 and 94% in Zone 7.

Figure 23. Sample Population

	All patients (n=29,170)							Positive cases (n=411)						
	All services	MMC	MC	VHC	VMV	ACD	SCD	All services	MMC	MC	VHC	VMV	ACD	SCD
Z3+7 n	29,170	74	5,226	1,633	3,896	1,949	16,392	411	-	371	7	16	6	11
Z3 n	9,629	3	2,871	1,235	2,785	1,181	1,554	195	-	183	1	7	4	-
Z7 n	19,541	71	2,355	398	1,111	768	14,838	216	-	188	6	9	2	11
Z3+7 %	100.00	0.26	17.91	5.60	13.35	6.69	56.19	100.00	-	90.27	1.71	3.89	1.46	2.67
Z3 %	100.00	0.03	29.82	12.83	28.93	12.26	16.13	100.00	-	93.85	0.51	3.58	2.05	-
Z7 %	100.00	0.35	12.06	2.05	5.69	3.92	75.93	100.00	-	87.04	2.78	4.12	0.92	5.09

Age :

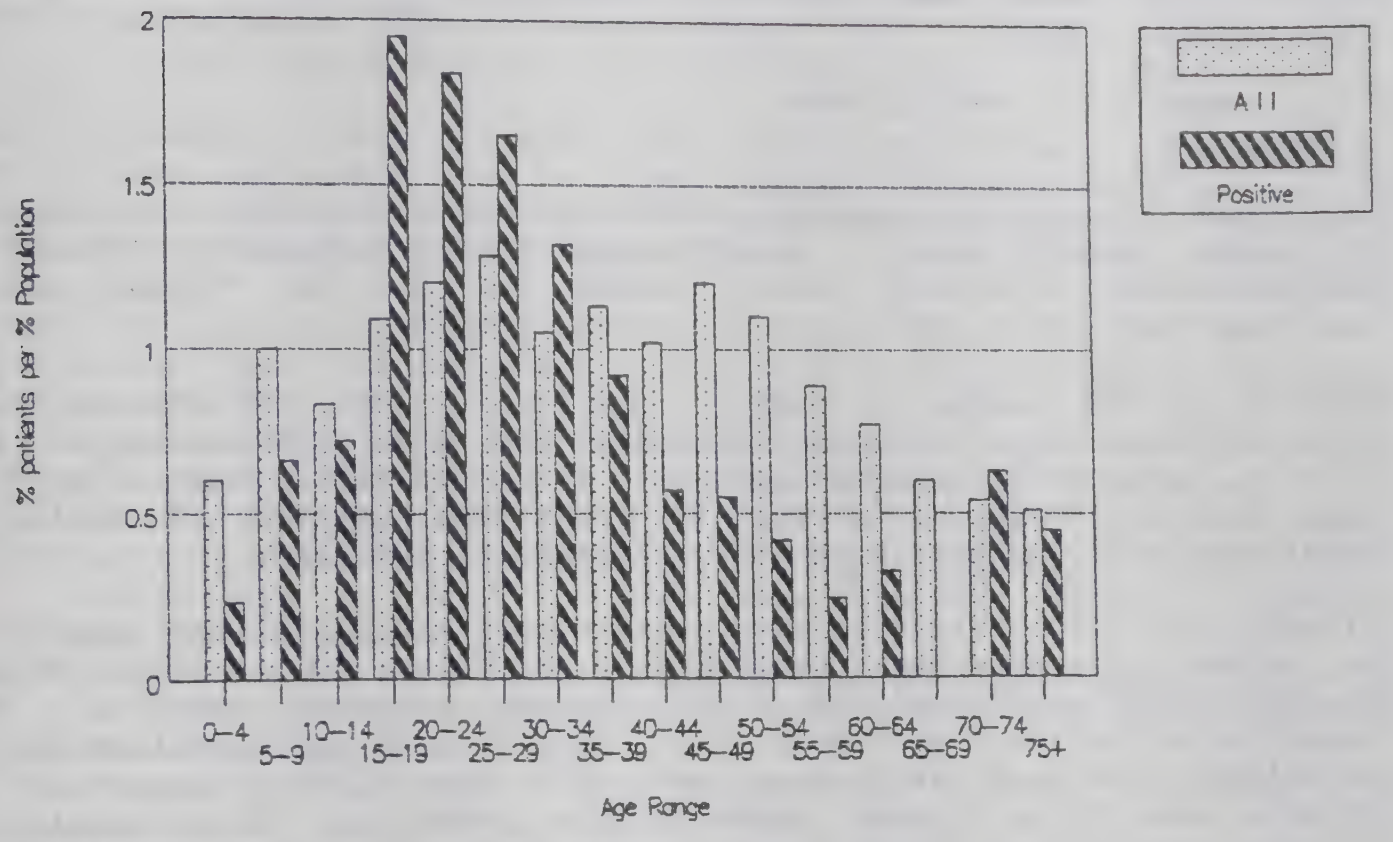
The average age of patients was 28.9 yrs. (Zone 3) and 24.0 yrs. (Zone 7) with little differences among services. Average age of positive cases was marginally lower at 23.7 yrs. and 23.0 yrs. respectively with significant differences among services. Taking both zones together the average age of positive cases was 16.6 yrs. for VHC, 23.4 yrs. for MC, and 26.9 yrs. for VMV. Perhaps a larger number of children are taken to VHC's and older people attend VMVs.

When the age profile of the sample of patients and positive cases from both zone is expressed in relation to the national age profile (Figure 24), the proportion of cases aged 15-34 is greater than the proportion of the population of that age. If the high proportion of cases in the range 15-34 is linked to exposure in the working environment, this raises questions about the value of house spraying.

Sex :

In Zone 3, 63% of patients are male and 56% in Zone 7. This compares with a national average of 50%. In terms of positive cases, 80% are male in zone 3 and 78% in zone 7.

Figure 24. Age Profile of Patients and Positive Cases in Relation to the National Population Profile



Occupation :

The occupation profile of patients and positive cases in Zone 3 and 7 are quite different (Figure 25). This reflects the larger town based population in Zone 3.

Figure 25. Occupations of Patients and Cases

Education :

In terms of all patients, 94.6% had primary education or lower. In Zone 3, 9.6% had secondary education or higher, compared with 2.1% in Zone 7. This difference became more marked with the positive cases; 22.5% in Zone 3 and 4.6% in Zone 7. This is profile is consistent with the occupations of cases.

Family size :

The number of people resident in the house at the time the respondent was ill averaged 3.8 in Zone 3 and 4.4 in Zone 7.

6.2 Behaviour

Response rate to questions concerning behaviour was never less than 97%.

6.2.1 Reasons for seeking care

In its health education campaign, the Malaria Division cites four reasons why people should have a blood sample taken; a headache with fever, previous history of having fever, travel out of the village and/or receiving visitors in the house from another village.

Analysis of the reasons for seeking care (by service) provides a picture of the response made to health education and some indication of any relation between the nature of services and their utilization. Positive cases might be expected to mirror the behaviour pattern of patients. Deviations would indicate some self selection of services.

Patients show a consistent pattern, within both zones, in the proportion who attend a service point because they had fever; 80% to 86% at MC and VHC, 70% to 77% at VMV and 43% to 54%, through outreach services. The proportion of patients who sought care, because they had travelled out of the village, averaged 14% in Zone 3 and 5% in Zone 7. The proportion of patients who cited "other reasons" for providing blood samples at outreach services was 30% in Zone 7 compared with 3% in Zone 3. Of the positive cases 92% cited fever and 6% being out of the village as reasons for seeking care.

6.2.2 Reasons for not attending the service (point) nearest to home

Reasons for seeking care at a particular service may have medical and social components. The service and service point selected may reflect a number of factors such as convenience, travel costs, quality of service or disappointment with treatment already received at another service point. Knowing the priorities among these reasons could have a bearing on decisions concerning the nature, siting and performance of services.

Reasons of patients :

Approximately 84% of respondents were not at their nearest service point (Figure 26).

Figure 26. Patients not Attending their Nearest Service

	Zone 3					Zone 7				
	MC	VHC	VMV	ACD	SCD	MC	VHC	VMV	ACD	SCD
n =	2,871	1,235	2,785	1,181	1,554	2,355	398	1,111	768	14,838
Not attending nearest service point %	92.0	42.2	24.8	98.6	89.8	94.8	71.1	67.8	98.7	94.4

Reasons given by patients who attended passive services, which were not nearest to their home, showed marked differences between zones.

Zone 3 Better service (49%) >, convenience (25%) >, other reasons (13%) >, not cured elsewhere (12%) >, lower travel cost (1%).

Zone 7 Convenience (55%) >, other reasons (19%) >, better service (13%) >, not cured elsewhere (12%) >, lower travel cost (1%).

The differences between MCs were particularly significant. In Zone 3, 74% of the patients, not at their nearest service point, went to the clinic because of better service or disappointment with prior treatment. In Zone 7, the proportion was only 28%.

Several conclusions may be drawn:

(i) Travel cost is not a key issue as all other factors have a higher priority.

(ii) Approximately 12% of patients claimed they were not cured elsewhere. Patients were therefore presenting themselves to a service for the second or third time for the same illness episode.

(iii) Better service has the highest priority in Zone 3 compared with convenience in Zone 7. What makes a service "better" is unclear and should be identified.

(iv) "Convenience" is a factor cited by 55% in Zone 7 and 25% in Zone 3. This is puzzling given the fact that they were not attending their nearest service point.

(v) In Zone 3, there is a clear polarization towards attending the nearest service or to attend an MC for better service.

Patients attending outreach services are, by definition, not at their nearest service point. But the high proportion at MC, VHC and VMV services shows that distance is not the major determinant.

Reasons given by patients using outreach services were :

Zone 3 - Better service (50%), not cured at another service (21%), other reasons (17%) and convenient travel (10%).

Zone 7 - Better service (69%), other reasons (12%), not cured at another service (8%).

Overall, 10% of the patients stated that they had not been cured at another service and were seeking a second blood smear examination.

Reasons of positive cases :

Since 90-92% of positive cases were identified at Malaria Clinics, the reasons cited by positive cases at these clinics dominate the overall response from both zones. The reasons cited have a similar distribution to the reasons given by patients at Malaria Clinics.

The proportion of cases who claimed they were not "cured" at another service rose to 19%. Whether this 19% of positive cases was diagnosed as negative through a previous service or exhibited some degree of drug resistance is not clear.

6.2.3 Actions taken before attending this service to treat this fever

Respondents, with fever, who answered these questions, were 58% of patients and 87% of positive cases.

Six points of significance emerge from the summary presented in Figure 27.

Figure 27. Actions Before Attending this Service

Actions taken %	Zone 3	Zone 7
1. No response	1.12	3.32
2. Attend MC	2.01	2.56
3. Attend VMV	4.49	8.22
4. Attend VHC	2.79	3.18
5. Attend Govt. Hosp.	3.55	1.57
6. Attend Private Clinic	2.98	0.82
7. Attend Quack	2.46	0.27
8. Self prescription	35.25	17.69
9. No action	43.72	57.77
10. Attend 2 + services	0.80	2.44
11. Others	0.83	2.16
	100.00	100.00

1. Order
   Actions can be placed in an order of decreasing proportion among the responses : No action > self prescription > visit Malaria Division service point > visit a government hospital > visit a private clinic > visit a "quack".

2. No previous actions
   No action was taken by 44% of patients in Zone 3 and 58% in Zone 7. Proportions were approximately 10% higher among outreach compared with passive services.

3. Self prescription
   Self prescription was the previous action taken by 23% of respondents (35% in Zone 3 and 18% in Zone 7). The lower proportion in Zone 7 was affected by the large number of SCD patients, of which, only 16% took this action.

4. Patients previously attending Malaria Division services
   Approximately 12% of patients reported that they had sought diagnosis and treatment at a Malaria Division service prior to attending the service at the time of interview (9.3% in Zone 3 and 13.9% in Zone 7). Of this 12% of patients, 17% had previously attended an MC, 58% a VMV and 25% a VHC. A lack of confidence in the diagnosis / treatment through a VMV would seem to be a major factor in some patients representing themselves for another blood check.

5. Patients previously attending a hospital or private clinic
   The proportion of patients who had sought care at a hospital or private clinic was 6.5% in Zone 3 and 2.4% in Zone 7. This difference undoubtedly reflects the higher income, education level and quantity of services available in Zone 3 (17 hospitals in Zone 3 compared to 9 in Zone 7).

6. Quack
   Only 1% of patients had sought care from a "quack".

6.3 Travel

Distance to service points is a determinant of behaviour in seeking care and affects the costs incurred by the patient.

6.3.1 Distance to the nearest service point and the service point attended

Approximately 84% of patients were not at their nearest service. But how far will patients be willing to travel to secure a better service or more convenience in travel?

The distance to the nearest service point of all patients in the two zones was compared with the distance travelled by patients and positive cases who were not at their nearest service point (Figure 28).

Figure 28. Average Distances to Service Points

	Distance of nearest service point All patients n = 29,170	Distance to passive service point being attended	
		All patients n = 10,829	Positive cases n = 394
% 0 (Km)	29.1	18.7	6.6
Av (Km)	1.9	6.2	13.1
Sd	3.5	10.9	12.2

Two conclusions can be drawn :

1. Patients attending passive service points, which are not the nearest points to home, are willing to travel about 3 times the distance to their nearest service.

2. Positive cases, largely identified at MCs, are willing to travel about 6 times the average distance to the nearest service point. There is, in effect, a self selection process; malaria cases travel further than patients who do not have malaria.

6.3.2 Means of travel

The behaviour of patients shows marked difference bet : zones and among services (Figure 29).

Figure 29. Major Means of Travel to Service Points (Unit %)

Major means of travel	Zone 3				Zone 7			
	All Services	MC	VHC	VMV	All Services	MC	VHC	VMV
Walk	19	6	14	35	41	29	46	66
Bicycle	30	15	40	41	9	7	19	11
Motor bike	18	18	22	15	8	9	14	3
Bus	27	56	18	2	30	46	16	5
Average Distance km.	6.9	13.8	4.2	1.1	6.6	9.4	2.7	1.8
Sd	11.8	14.6	8.3	2.7	9.1	10.1	3.4	4.3

Differences between the zones are mainly in the proportion of patients walking rather than using bicycles and motorcycles. Since distances to services in each zone are similar, the difference may be due to the fact that Zone 3 is more affluent and is largely flat.

6.4 Implications

1. Malaria in the population
   The distinctive age profile of positive cases in each zone and the male : female sex ratio (3.8:1) raise two interesting questions : (i) Where are the places in which infection occurs and what is the contribution of house spraying? (ii) What is the relationship among exposure, immunity and age?

2. Reasons for seeking care
   A large proportion of ACD and SCD patients (43%-54%) did not cite headache and fever as the reason for seeking diagnosis. This is a significant proportion of the total number of blood slides (30%). Since 92% of positive cases had a fever and 6% have been "outside the village", perhaps the questions asked when screening ACD and SCD patients should be reviewed.

3. Reasons for not attending the nearest service point
   A major concern must be the 19% of positive cases (largely at MCs) who cite dissatisfaction with another service point as a reason for seeking diagnosis and treatment. This also has implications for the pool of infection since this group are presumably infective for a longer time. There is some evidence that when "convenience" is satisfied, attention then focusses on better services. The nature of "convenience" and " better service" have to be clarified.

4. Previous service attended to cure this fever
   Approximately 23% of respondents took drugs before seeking diagnosis. The nature of this self prescription should be analysed to see if it involves antimalarial drugs.

   Responses to this question also show that 12% of patients are presenting themselves for diagnosis at a service point for the second time. This double diagnosis raises the workload on the service but is clearly necessary if 19% of all positive cases are diagnosed on the second attempt.

5. Patients are willing to travel considerable distances for convenience, service and a second diagnosis. Positive cases, largely identified at MCs, travel twice the average distance of all patients. The people with malaria seem to know that the best service point for their immediate diagnosis and treatment is a Malaria Clinic.

7. COSTS INCURRED BY PATIENTS

To optimize operational efficiency in control (outcome of control/input, for a given technology), costs incurred by the Malaria Division and by patients have to be considered. Costs incurred by patients are the direct and indirect costs as a result of an illness episode, a blood slide being taken and, in the case of positive cases, radical treatment (R.T.) administered.

Results of the survey are presented and analysed in three sections.

1. Direct and indirect costs to patients.
2. Direct and indirect costs to positive cases.
3. The influence of labour substitution.

Costs are calculated as total costs incurred by the sample divided by the number of people in the sample. Since a large proportion of the sample incurred no costs, the average is lower and Sd higher than that of the population incurring costs. For example, 50% of patients did not have time off work before seeking care, and 80% incurred no travel costs.

7.1 Direct and Indirect Costs Incurred by Patients

Costs incurred by patients are summarized in Figure 30.

Figure 30. Average Costs to Patients

Type of Costs	Zone 3		Zone 7	
	Average of all services		Average of all service	
	Baht	%	Baht	%
DIRECT (Patient)				
Explicit (actual expenditure)				
- travel to service point	6.8	3.3	4.5	2.8
- food during visit	5.5	2.8	4.9	3.1
- treatment prior to visit	34.8	17.6	25.4	15.9
: total explicit	46.9	23.7	34.8	21.8
Implicit (time costs)				
- sick leave before visit	87.1	44.1	63.7	39.9
- travel time	37.7	19.1	26.7	16.7
- waiting for diagnosis and treatment	-	-	-	-
: total implicit	124.8	63.2	90.4	56.6
Total direct costs	171.7	86.9	125.2	78.4
INDIRECT (Accompanying person)				
Explicit				
- travel to service point	4.6	2.3	4.3	2.7
- food during visit	8.9	4.5	7.9	4.9
: total explicit	13.5	6.8	12.2	7.6
Implicit				
- travel time	12.4	6.3	22.1	13.9
Total indirect costs	25.9	13.1	34.3	21.5
GRAND TOTAL	197.6	100.0	159.5	100.0

Average costs per patient for the two zones is 173 Baht of which 83% is direct costs; 72% of which is implicit (time costs). Patients attending at Malaria Clinics incur the highest implicit costs; 254 Baht (Zone 3) and 193 Baht (Zone 7) largely due to sick leave and self treatment before seeking care.

7.2 Direct and Indirect Costs Incurred by Positive Cases

Average costs / positive case are summarized in Figure 31. Positive cases are largely a special subset of the patients attending Malaria Clinics (90%). The average costs incurred by all positive cases is 534 Baht, 80% of which is direct costs.

Figure 31. Average Costs to Positive Cases

Type of Costs	Zone 3 (n = 195)		Zone 7 (n =216)	
	Average of all services		Average of all service	
	Baht	%	Baht	%
DIRECT (Patient)				
Explicit (actual expenditure)				
- travel to service point	7.4	1.3	8.3	1.6
- food during visit	15.8	2.8	8.5	1.6
- treatment prior to visit	80.0	14.1	39.9	7.7
: total explicit	103.2	18.3	56.7	10.9
Implicit (time costs)				
- sick leave before visit	171.0	30.3	150.8	29.0
- travel time	40.3	7.1	46.8	9.0
- waiting for diagnosis and treatment	143.7	25.4	146.3	28.1
: total implicit	355.0	62.8	343.9	66.1
Total direct costs	458.2	81.1	400.6	77.0
INDIRECT (Accompanying person)				
Explicit				
- travel to service point	5.1	0.9	6.2	1.2
- food during visit	28.0	5.0	14.9	2.9
: total explicit	33.1	5.9	21.1	4.0
Implicit				
- travel time	73.5	13.0	98.2	18.9
Total indirect costs	106.6	18.9	119.3	23.0
GRAND TOTAL	564.8	100.0	519.9	100.0

Time costs of cases at VHCs and VMVs are twice the costs of cases at attending Malaria Clinics (550-660 Baht) due to waiting for diagnosis and treatment.

7.3 Labour Substitution

In the estimation of costs to patients, two assumptions are made. First, time away from work is costed at the minimum wage rate (65 Baht / day). Second, there is no labour substitution, i.e., there is no loss of production and income because work is done by unemployed relatives/ friends. In practice, neither assumption is correct. A special survey

concerning labour substitution (n=2,875) provided some insights into the situation.

Time costs :

Average income was 12,200 Baht/year (Sd 15,000) with an average of 10,900 Baht/year from the major occupation and 1,300 Baht/year from minor occupation(s). Based on the average income and six working day a week, the real income is 39 Baht/day. This means that time costs assumed in the computation, using minimum wage rate to patients, was over optimistic.

Some 816 persons (28.4%) had a person substitute for them at work during their current illness. The husband substituted in 28.9% of cases, the wife in 50%, a son/daughter in 15.2% of cases, and 4.4% employed another person. No responses was given by 1.4%. Assuming this 1.4% did not employ another person then 27.1% benefitted from labour substitution.

Implication :

If the sample population is representative of all positive cases then time costs in Sections 7.1, 7.2 must be multiplied by a factor of 0.46 (0.6 in respect of the lower actual income rate and by a further factor of 0.73 because 27.1% of the cases have a labour substitute). Results for cases are shown in Figure 32.

Figure 32. Effect of Actual Income Rate and Labour Substitution on Costs to Positive Cases

Type of costs		All services		MC		VMV	
		Original	Adjusted	Original	Adjusted	Original	Adjusted
Direct	Explicit	78.0	78.0	82.0	82.0	39.0	39.0
	Implicit	350.0	154.0	277.6	122.1	561.0	246.8
	Sub total	428.0	232.0	359.6	204.1	600.0	285.8
Indirect	Explicit	25.9	25.9	26.1	26.1	0.0	0.0
	Implicti	80.5	35.4	85.8	37.7	65.0	28.6
	Sub total	106.4	61.3	111.9	68.8	65.0	28.6
	Total	534.0	293.3	471.5	275.2	665.0	326.9

The difference between the costs to cases at MCs and VMVs is thus reduced to 66 Baht. The average costs to cases at VMV services will equal that at MC services, if the time between taking a blood slide and providing radical treatment at VMVs can be reduced by two days (average 6 days).

However, neither the explicit nor implicit costs appear to be a significant constraint when positive cases seek care at an MC.

8. APPLICATION OF MODELS

It is not possible, at this stage, to apply the four models to the two zones and sectors. Many of the parameters have yet to be determined. However, given a number of assumptions it is possible to test two of the models (Pool of Infection and Cases Prevented) with currently available data. In the absence of sensitivity analysis, the significance of the assumptions is uncertain.

8.1 Pool of Infection Model

Assumptions :

1. The same proportion of Pf and Pv malaria cases occur in each type of service (43.1% and 59.9% in Zone 3; 51.1% and 48.9% in Zone 7). These are the average figures of each zone.
2. Pf malaria cases remain infective for 1 day (average) after receipt of radical treatment (R.T.).
3. Number of days with fever before seeking care at a hospital is 4.5 days in Zone 3 and 3.5 days in Zone 7. These are average figures for all services in each zone.
4. Pv malaria cases remain infective for 2 days (average) after receipt of R.T.
5. 21.5% of positive cases detected through ACD, SCD, MMC, VMV and VHC in Zone 3 received presumptive treatment (P.T.) and 34% in Zone 7 (average percentage of P.T. dispensed in Zone 3 and Zone 7).6. A positive case which receives P.T. is non-infective for 4 days (average).
7. The proportion of false negatives is 0.44% (average of Region 1 in 1986).
8. Average time (days) between taking a blood slide and providing R.T. to false negative patients, (Tse) is 23 days (average of total Division).
9. Average number of days with fever before false negative first seek services is 4.5 days in Zone 3 and 3.5 days in Zone 7 (average of positive cases at all services in each zone).
10. 10% of recrudescent among Pf malaria cases.
11. 50% of relapse among Pv malaria cases.
12. Average time (days) recrudescent Pf malaria cases are infective, (t5), is 15 days.
13. Average time (days) relapsed Pv malaria cases are infective, (t6), is 30 days.
14. Average time (days) undetected Pf & Pv malaria cases are infective, (t7), is 60 days.
15. Proportion of cases detected to cases existed is 40% (from previous study).
16. Average time (days) detected Pf malaria cases, who do not receive R.T., remain infective, (t3), is 35 days.
17. Average time (days) detected Pv malaria cases, who do not receive R.T., remain infective, (t4), is 60 days.
18. The percentage of Pf & Pv malaria cases not receiving R.T. is 10% in Zone 7 and 0% in Zone 3 (zone data).

Application of these data for 1986 to the model yields 124,000 infective mandays for Zone 3 and 190,000 for Zone 7. Components contributing to

high figures are the ratio of cases detected to cases existed, the number of days between initial blood slide examination and treatment of false negatives, the number of days between taking a blood slide and provision of radical treatment, proportion of cases receiving radical treatment, and patient's performance in terms of days with fever before seeking treatment.

When expressed as Annual Infective Mandays per 1,000 population days (AIM), the results can be compared with API.

Zone 3	API = 1.4/1000	AIM = 118/1000
Zone 7	API = 2.3/1000	AIM = 317/1000

It would be rash, at this stage, given the many assumptions, to draw any conclusions from these numbers but the model can clearly be applied.

8.2 Cases Prevented Model

Assumptions made for the Pool of Infection Model are also applied in the Cases Prevented Model. One additional assumption is made. In the absence of data on average infective days of a case in the population, the SPR of SCD services of each zone is used to determine the value of expected infective mandays in the population. To determine these times, in practice, requires epidemiological study of identified and unidentified Pf and Pv cases together with recrudescent and relapsed cases.

Given these assumptions, the number of mandays prevented in Zone 3 is 511,000 and in Zone 7 61,000.

8.3 Short-run Cost Model and Aggregate Cost Model

From currently available data on internal and external costs, it should be possible, given further work, to determine the Short Run-Internal Cost Function for each zone and/or sector.

Application of the Aggregate Cost Model requires information on two aspects; costs incurred by patients (already available) and measurement of the coefficients of the variables in the long-run.

9. CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations are presented in three sections :

1. Conclusions with respect to short term objective.
2. Conclusions with respect to medium term objectives.
3. Recommendations.

9.1 Short Term Objectives

Short term objectives (Section 1.2) have been fully met although one objective, strengthening of the research competence of Malaria Division staff, is difficult to quantify.

9.1.1 Internal costs and performance

Measurement of costs

1. A system has been developed for determining the internal costs to Malaria Division operational units, operational activities and field services by apportionment (Section 3.1.1) and by direct measurement of expenditures under budget headings (3.1.2).
2. Costs can be expressed at any level. Thus sector costs at the Division level show the amount and proportion of 'overhead' costs from zone, region and Division headquarters (Section 3.1).
3. Criteria for apportionment were refined until apportioned and measured costs show no significant difference at the 95% confidence limit.
4. Both a primary survey and Divisional records of centrally purchased supplies yielded uncertainties concerning the quantities of centrally purchased supplies consumed (drugs, chemicals pray and laboratory supplies). Criteria were therefore developed to determine 'Estimated Costs of Necessary Consumption' (ECNC). This ECNC was used when determining the total costs of operational units and field services (Section 5.2.2).

Sector costs at zone level

1. Surveillance costs vary between 30-90 Baht per blood slide and 3,300-3,400 Baht per positive case. The labour / materials cost ratio varies between 15:1 to 40:1.
2. Vector control costs vary between 75 and 180 Baht / house sprayed. The labour materials cost ratio is 2:1 (Zone 7) and 5:1 (Zone 3).

Field service costs at zone level

1. Costs per blood slide in Zone 3 and 7 are : VHC (14-47 Baht/slide), VMV (80 Baht/slide), MC (66-109 Baht/slide), ACD and SCD (15-113 Baht/slide) [Section 5.4.2].
2. Costs per positive case in Zone 3 and 7 respectively are : VHC (1,200-5,800 Baht/case), VMV (5,00-14,000 Baht/case), MC (620-1,500 Baht/case), SCD (17,000-67,000 Baht/case), ACD (11,000-208,000 Baht/case) and MMC (14,000-38,000 Baht/case).

Malaria clinic costs at field level

1. When the costs of MCs are assigned only to clinic patients or positive cases, average costs are 40 Baht/clinic patient and 350-550 Baht/positive case.
2. When costs of MCs are divided in proportion to the relative time given to clinic patients, to positive cases and to the examination of slides for other services average costs are 7-14 Baht/clinic patients, 103-130 Baht/positive case and 4-6 Baht/service slide.
3. Based upon assumptions concerning production capacity and average costs of MCs, the minimum costs at field level would be 4.4 Baht/clinic patient, 44 Baht/positive case and 2 Baht/ service slide.

'Overhead' costs

1. On average, 57% of sector costs are incurred at the sector level, 26% from the zone, 12% from the region and 5% from the Division.

9.1.2 Costs incurred by patients

1. Based on the minimum wage rate, direct and indirect costs incurred by patients average 170 Baht of which 80% is direct cost 72% of the direct cost is time cost (Section 7.1).
2. Direct and indirect costs incurred by positive cases average 530 Baht of which 80% is a direct cost. 81% of the direct cost is time cost (Section 7.2).
3. When average income and labour substitution are taken into account, average costs incurred by each positive case falls to 300 Baht.

9.1.3 Performance of malaria services

1. The average number of days between taking a blood slide and providing radical treatment to positive cases, in the two zones, is 2.2 days (Sd 3.0). Average times for services in 1986 were MMC (4.0 days), MC (1.0 days), VHC (7.6 days), VMV (5.9 days), ACD (6.2 days), SCD (5.9 days).

9.1.4 Behaviour of patients in seeking care

Population :

1. The sample population (n=29,170) is fully described in terms of the number of patients and positive cases using particular services and by age distribution, sex, occupations education and family size (Section 6.1).

Behaviour :

1. Some 84% of respondents did not attend their nearest service point. Reasons given for this behaviour were different in each zone with 'convenience' and 'better service' being the major reasons.
2. Travel costs are not reported as a key factor in determining which service point to attend.
3. 12% of patients reported that they were presenting themselves at a service point because they were not 'cured' at another service.
4. 19% of positive cases reported they had attended another service point but were not cured.
5. Prior to seeking care, 53% of patients took no other actions, 23.5% took self prescribed drugs, 12% had attended other Malaria Division services and 3.7% had sought care at a hospital or private clinic (Section 6.2.3).

Travel to service point :

1. Average distance for all patients to the nearest service point was 1.9 km, but 6.8 km to the service point attended. Positive cases travelled an average of 13.1 km to receive treatment (Section 6.3.1).
2. Means of transport to visit a service point depended upon the community and conditions; 30% used a bus, 20-40% walked, 10-30% used a bicycle and 8-18% a motorbike.

Performance (time between onset of symptoms and seeking care) :

1. The proportion of patients attending a service point because they had a fever was 80% to 86% for MC and VHC, 70% to 77% for VMV and 43% to 54% for ACD and SCD.
2. Among positive cases 92% cited a fever as the reason for seeking care and 6% because they had been away from the village.
3. The number of days between the onset of symptoms and seeking care averaged 2.2 days for all patients and 3.9 for positive cases.

9.2 Medium Term Objectives

Three features of the work should contribute to achievement of the medium-term objective : (1) Information on current costs and performance has been produced (Section 9.2). (2) Models to improve the efficiency of surveillance have been developed. (3) Tools have been made available to the Malaria Division which could be used in subsequent monitoring.

9.2.1 Models to improve the efficiency of surveillance

Four measures have been developed through mathematical modelling which could be used as tools to improve the effectiveness and efficiency of control operations; a pool of infection model, cases prevented model, internal cost model, and an aggregate cost model. A further development will be to relate the trade off between the pool of infection and costs (Section 3.4).

1. The pool of infection model (number of mandays there are infective carriers in a community) can be used to identify where strengthening of surveillance will be most effective.
2. The cases prevented model suggests how cases prevented in the year will be influenced by SCD and MBS effectiveness, the performance of services in providing R.T. and the performance of patients in seeking care.
3. The internal cost model provides guidelines, under short run static conditions, on the most effective actions to reduce the pool of infection, having regard to the internal costs of alternative action.
4. The aggregate cost model suggests how best to redistribute services and what type of services should be increased or decreased so that aggregate costs are minimized.
5. The pool of infection and cases prevented models have been applied to the two zones, using data from the current study, and some assumptions based, in part, upon previous work (Kaewsonthi and Harding 1986c).

9.2.2 Tools for monitoring

A number of 'tools' have been made available to the Malaria Division.

1. Computer programmes (in Thai) for :

   - Stock control and analysis of the consumption of centrally purchased supplies.
   - Financial control (budget, expenditure and balance under each budget item for each operational unit).
   - Costs control for operational units and field services by measurement and apportionment.
   - Staff control and time analysis.
   - Performance monitoring and control through information currently recorded in surveillance report form No.6.
   - Consumers' record and analysis of consumers' behaviour (patients' information and costs incurred by patients).

2. Conceptual tools have been proposed which include :

   - Use of apportioned costs to estimate budgets and to improve operational management.
   - Criteria for determining the estimated costs on necessary consumption of drugs, chemical spray materials and laboratory supplies.
   - Labour/materials cost ratios for analysing the gross performance of each sector.
   - Performance analysis for malaria clinics.

9.3 Recommendations

The work has provided information and tools which have immediate significance and application in the longer term. It has also yielded a number of issues which warrant further work. The recommendations

therefore fall under two headings; investigations and applications. Broadly, these two areas refer to the models and to the tools for monitoring described in Section 9.2.

9.3.1 Investigations

1. Pool of infection
   Identify important parameters in the Pool of Infection Model, test it over a period of time in a range of areas, and measure the sensitivity of the model to assumptions and ranges of parameters.

2. Case prevented model
   Apply the model in some test areas to monitor cases prevented and explore how the cases prevented can be increased by improved SCD practices.

3. Cost model
   Determine the coefficients of the cost models in the short-run and long-run and analyse the sensitivity of costs to ranges of parameters and variables.

4. A number of small studies should be made to more fully investigate the determinants of patients behaviour and how services of the Malaria Division could respond.

5. Develop a production model for malaria clinics which takes into account their production capacity for patients and service slides and the relation between SCD activity, costs and cases prevented.

6. Investigate optimum routing for regular collection and delivery of blood slides to MCs to minimize cost and time.

9.3.2 Applications

The cost and performance data, conceptual framework and computer programmes derived from this study, together with advances in medical technology, provide the Malaria Division with the tools to plan its strategy for the next 5 years.

The Division should be helped to develop a strategic plan in which ;

- the mission is clarified and reviewed;
- an environmental analysis is undertaken i.e. the internal strengths and weaknesses together with external threats and opportunities in this dynamic environment are detailed;
- new goals and targets are established in the light of the mission and environmental analysis;
- actions in the reallocation of manpower and resources are planned and scheduled.

Development of the strategic plan must be an iterative process, undertaken and managed by the Malaria Division, with the participation of the Department of Communicable Disease Control and contributions from the WHO and economic/planning consultants.

REFERENCES

Barlow, R., Grobar, L.M. (1986)
Costs and benefits of controlling parasitic diseases
World Bank PHN Technical Note 85-17

Kaewsonthi, S. (1983)
Cost and performance appraisal of malaria surveillance and monitoring measures
Final Report TDR Project No.800435, WHO, Geneva

Kaewsonthi, S. (1984)
Cost and performance appraisal of malaria surveillance and monitoring measures in Thailand
Malaria Research Conference, Ministry of Public Health
Chiangmai (December 1984)

Kaewsonthi et al. (1989)
Costs and Performance of Malaria Surveillance and Monitoring in Thailand : A retrospective Study Based Upon Apportionment of Expenditure Under Budget Headings
Social and Economic Research Project No.5
UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases, Geneva

Kaewsonthi, S., Harding, A.G. (1984)
Cost and performance of malaria surveillance in Thailand
Soc. Sci. Med. Vol.19, No.10, pp. 1081-1097

Kaewsonthi, S., Harding, A.G. (1986 a)
Economic problems of parasite control programme
Sixth International Congress of Parasitology, Brisbane

Kaewsonthi, S., Harding, A.G. (1986 b)
Cost and performance of malaria surveillance : The patients' perspective
South East Asian J. Trop. Med. Pub. Health Vol.17, No.3, September 1986

Kaewsonthi, S., Harding, A.G. (1986 c)
Cost containment in health care services
Proceedings of the Second International Symposium on Public Health in South East Asian and Pacific Basin
Mahidol University, Bangkok

Kaewsonthi, S., Harding A.G. (1986 d)
Role of village volunteers in control of mosquito-borne disease-social and economic costs
Community Participation for Disease Vector Control
Proceedings of the ICMR/WHO Workshop, Malaria Research Centre, Delhi

Kaewsonthi, S., Malikul, S. (1986)
Patient behaviour and patient costs
Second Conference on Malaria Research, Pattaya, Thailand

Kondrashin, A.V. (1986)
Population movements and malaria in the WHO South East Asia Region Second Conference on Malaria Research, Pattaya, Thailand

Malaria Division (1985)
1985 Annual Report, Malaria Division, Ministry of Public Health, Bangkok

Mills, A.J. (1987)
Economic study of malaria in Nepal : The cost effectiveness of malaria control strategies
Evaluation and Planning Centre for Health Care, London School of Hygiene and Tropical Medicine

Ministry of Public health (1986)
Public Health Statistics
Dept. of Statistics, The Ministry of Public Health, Thailand

Pinichpongse, S. (1986)
Malaria control in Thailand
proceedings of Second Conference on Malaria Research, Malaria Division, Ministry of Public Health, Thailand

World Health Organisation (1957)
Expert Committee on Malaria 1957 (Sixth report)
Technical Report Series, No.123, Geneva

World Health Organisation (1985)
Informal consultation on stratification for planning antimalarial action
Moscow 3-7 June (INP/CONS/WP/85.0)

World Health Organisation (1986)
Expert Committee on Malaria
Technical Report Series, No.735, Geneva

Appendix 1

1.1 Pool of Infection Model (PI)

The Model (PI)*

$$PI = \sum_{i=1}^{7} a_{1i} N_{fi} (T_{si} + T_{fi} + t_1) + \sum_{i=1}^{7} a'_{1i} N_{vi} (T_{si} + T_{vi} + t'_1) + \sum_{i=1}^{7} (1 - a_{1i}) (N_{fi}) (T_{fi} + t_3)$$

$$+ \sum_{i=1}^{7} (1 - a'_{1i}) (N_{vi}) (T_{vi} + t_4) - \sum_{i=1}^{7} a_{2i} (N_{fi} + N_{vi}) (t_2) + \sum_{i=1}^{7} N_{fei} (T_{se} + T_{fi} + t_1)$$

$$+ \sum_{i=1}^{7} N_{vei} (T_{se} + T_{vi} + t'_1) + N_{fr} (t_5) + N_{vr} (t_6) + N_{fu} (t_7) + N_{vu} (t_8)$$

Variable and parameters

PI = Pool of infection (mandays of infective carriers per year)

N_{fi} = number of Pf malaria cases detected through service i

N_{vi} = number of Pv malaria cases detected through service i

N_{fei} = number of Pf malaria cases existing in the population of reported negative blood slides of service i as a result of rechecking a sample of negative blood slides (false negative)

N_{vei} = number of Pv malaria cases existing in the false negative slides of service i

N_{fr} = number of recrudescence Pf malaria during the year

N_{vr} = number of relapsed Pv malaria cases during the year

N_{fu} = number of Pf active carriers who remain undetected per year

N_{vu} = number of Pv active carriers who remain undetected per year

a_{1i} = proportion of Pf malaria cases, detected through service i, receiving radical treatment

a'_{1i} = proportion of Pv Malaria cases, detected through service i, receiving radical treatment

a_{2i} = proportion of positive cases detected through service i, receiving presumptive treatment by service i

T_{si} = average time (days) between taking a blood slide and providing radical treatment by service i (performance of service)

T_{fi} = average time (days) between onset of symptoms and Pf patients presenting themselves for diagnosis at service i

T_{vi} = average time (days) between the onset of symptoms and Pv patients presenting themselves for diagnosis at service i

T_{se} = average time (days) between taking a blood slide and providing radical treatment to false negative patients

t_1 = average time (days) a Pf malaria case is still infective after receipt of radical treatment

t'_1 = average time (days) a Pv malaria case is still infective after receipt of radical treatment

t_2 = average time (days) a positive case receiving presumptive treatment is non infective

t_3 = average time (days) detected Pf malaria cases who do not receive radical treatment remain infective

t_4 = average time (days) detected Pv malaria cases who do not receive radical treatment remain infective

t_5 = average time (days) recrudescence Pf malaria cases are infective

t_6 = average time (days) relapsed Pv malaria cases are infective

t_7 = average time (days) undetected Pf malaria cases are infective

t_8 = average time (days) undetected Pv malaria cases are infective

i = 1.....7 represent the 7 types of services ;MC, MMC, VMV, VHC, ACD, SCD, MBS

---

* Plasmodium malariae (Pm) is only 0.4% in Thailand so it is included with the Pf cases in this model.

1.2 Cases Prevented Model (CP)

The Model (CP)

$$N_{pt} = N_{pft} + N_{pvt}$$

$$N_{pt} = \left[\left\{ \left(\frac{S_{pf}}{Sd_1} \right) (P_{dt}) \right\} - \left\{ (N_{ft})(T_s + T_f) + \left(\frac{1 - a_1}{a_1} \right) (N_{ft})(T_{fu}) \right\} \right.$$

$$\left. + \left\{ \left(\frac{S_{pv}}{Sd_2} \right) (P_{dt}) \right\} - \left\{ (N_{vt})(T_s + T_v) + \left(\frac{1 - a_2}{a_2} \right) (N_{vt})(T_{vu}) \right\} \right]$$

Variables and parameters

N_{pt} = total number of positive mandays being prevented in year t

N_{pft} = number of positive mandays being prevented from Pf malaria in year t

N_{pvt} = number of positive mandays being prevented from Pv malaria in year t

N_{ft} = number of Pf malaria cases detected in year t

N_{vt} = number of Pv malaria cases detected in year t

T_s = average time (days) between taking a blood slide and providing radical treatment (performance of service)

T_f = average time (days) between the onset of symptoms and Pf patients presenting themselves for diagnosis

T_v = average time (days) between the onset of symptoms and Pv patients presenting themselves for diagnosis

T_{fu} = average time (days) undetected Pf malaria is infective

T_{vu} = average time (days) undetected Pv malaria is infective

a_1 = probability of Pf malaria (cases) being detected

a_2 = probability of Pv malaria (cases) being detected

Sd_1 = number of sample days through SCD and MBS (Pf malaria) (number of slides taken by SCD and MBS × Tf)

Sd_2 = number of sample days through SCD and MBS (Pv malaria) (number of slides taken by SCD and MBS × Tv)

S_{pf} = number of Pf positive days detected within the sample days through SCD and MBS

S_{pv} = number of Pv positive days detected within the sample days through SCD and MBS

P_{dt} = number of population days being covered by surveillance during year t

1.3 Short-Run Internal Costs Model

The Model

$$B = \sum_{i=1}^{7} (b_i N_{ni} + a_{fi} N_{fi} + a_{vi} N_{vi} + a_{fei} N_{fei} + a_{vei} N_{vei} + a_{fr} N_{fr} + a_{vr} N_{vr})$$

Variables and Parameters

N_{fi} = number of Pf malaria cases detected through service i

N_{vi} = number of Pv malaria cases detected through service i

N_{ni} = number of negative blood slides collected through service i

N_{fei} = number of Pf malaria cases detected through rechecking and cross checking blood slides (false negative)

N_{vei} = number of Pv malaria cases detected through rechecking and cross checking blood slides (false negative)

N_{fr} = number of recrudescence Pf malaria (recurrent cases)

N_{vr} = number of relapsed Pv malaria cases

b_i = cost per blood slide examined through service i

a_{fi} = cost per case for detection and treatment of Pf malaria through service i

a_{vi} = cost per case for detection and treatment of Pv malaria through service i

a_{fei} = cost per case for detection and treatment of false negative Pf malaria

a_{vei} = cost per case for detection and treatment of false negative Pv malaria

a_{fr} = cost per case for detection and treatment of recrudescence Pf malaria

a_{vr} = cost per case for detection and treatment of relapsed Pv malaria (rechecked and retreated)

B = total budget allocated to surveillance services

i = i = 1, 2, 3, ..., 7 represent 7 types of services ; MC, MMC, VMV, VHC, ACD, SCD, MBS

1.4 Aggregate Cost Model

1.4.1 Cost to Malaria Division Model

The Model

$$TC = \sum_{i=1}^{7} [A_i + a_i \{N_i - (N_{fi} + N_{vi})\} + (b_i N_{fi} + c_i N_{fi}^2 + d_i N_{fi}^3) + (g_i N_{vi} + h_i N_{vi}^2 + k_i N_{vi}^3)]$$

Variable and parameters

TC_i = total cost to Malaria Division by service i

A_i = total fixed costs required for service i

N_{fi} = number of Pf malaria cases detected and treated through service i

N_{vi} = number of Pv malaria cases detected and treated through service i

N_i = number of patients (positive + negative) attending service i

a_i = cost per blood slide taken and examined through service i

b_i c_i d_i = coefficient of cost function for detection and treatment of Pf malaria

g_i h_i k_i = coefficient of cost function for detection and treatment of Pv malaria

1.4.2 Cost to Patients Model

The Model

$$TC_p = \sum_{i=1}^{7} [\{N_{ni}(T_{ei} + wT_i)\} + \{wN_{fi}(T_i + T_{fi} + T_{si})\} + \{wN_{vi}(T_i + T_{vi} + T_{si})\} + \{T_{ei}(N_{fi} + N_{vi})\} + \{(T_{rfi}N_{fi}) + (T_{rvi}N_{vi})\} + \{N_{ni}P\}]$$

Variables and parameters

TC_p = total costs to patients

P = average expenses on self treatment of non positive patients before seeking care of service i

T_{rfi} = average expenses on self treatment of Pf malaria patients before seeking care by service i

T_{rvi} = average expenses on self treatment of Pv malaria patients before seeking care by service i

T_{ei} = average travel expenses of patients in attending service i

T_i = average travel time (days) of patients in attending service i

w = minimum wage rate per day

1.4.3 Aggregate Costs Model

$$TCS = TC + TC_p$$

$$= \sum_{i=1}^{7} [A_i + a_i \{N_i - (N_{fi} + N_{vi})\} + (b_i N_{fi} + c_i N_{fi}^2 + d_i N_{fi}^3) + (g_i N_{vi} + h_i N_{vi}^2 + k_i N_{vi}^3)]$$

$$+ \sum_{i=1}^{7} [\{N_{ni}(T_{ei} + wT_i)\} + \{wN_{fi}(T_i + T_{fi} + T_{si})\} + \{wN_{vi}(T_i + T_{vi} + T_{si})\} + \{T_{ei}(N_{fi} + N_{vi})\} + \{(T_{rfi}N_{fi}) + (T_{rvi}N_{vi})\} + \{N_{ni}P\}]$$